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MASTERS THESIS

Designing Instruction: the creation of learning materials to facilitate self-instruction of a computer drawing application

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to ***Pat***

for showing me how to climb mountains

to ***Yvette, Patti, and Joanne***

for showing me how to keep my feet on the ground

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ABSTRACT

This thesis is intended to demonstrate how visual communication design and instructional design are equal partners in motivating and enabling students to achieve desired learning outcomes—particularly the learning of computer applications.

This project involved the development of instructional materials to facilitate competency in the use of AutoCAD 2002 software in a post-secondary interior design curriculum. It was selected based on its merit as a user-centred, inter-disciplinary visual communication design problem. It addressed a need by creating educational materials which enabled students to learn a complicated computer software program needed to advance their skills in the interior design profession.

The design of the instructional materials involved an analysis of the needs of a specific user group; a review of current literature pertaining to educational theory, visual communication design and usability testing; creation of an initial prototype centred on the needs of the target audience; and testing and revision of the prototype based on evaluation of test results.

Research findings indicated that the success of the instruction was inextricably linked to the manner in which it was presented visually, and the quality of the design was dependent upon the content and organization of the curriculum. This would suggest that, rather than distinguishing visual communication and instructional design as two separate activities, with one playing a more substantive role than the other, both activities should be considered as equally important for implementing a successful curriculum. Just as it is important to possess both written and spoken communication skills for teaching in the classroom, it may be desirable that an instructor should also possess the necessary skills to interpret and compose visual elements in order to communicate content effectively—particularly where visual media form the basis in which instruction is conveyed, as is the case with learning computer programs through self-instruction.

INTRODUCTION

Most computer users can recall their first attempt to acquire computer skills. Whether through experimentation and exploration, through structured courses and workshops, tutoring by peers, or studying self-instruction manuals, people were, and still are, faced with learning this new technology in order to function skillfully in a work environment dominated by computers.

Acquisition of computer skills has become an on-going endeavor. As newer versions of operating systems and software applications are created, people are compelled to return to workshops and self-instruction guides in order to master the most recent iterations of a computer's interface. It has become apparent that computers are a form of technology that requires a continual investment in time, energy, and money, in order to master its functions and to keep abreast of its ever-changing interface.

The industry devoted to teaching computer skills has expanded to meet this demand for continuing computer education. This is evident by the number of schools and courses which have been developed in recent years that concentrate solely on computer training, as well as the proliferation of instructional manuals devoted to learning computer applications. Computer reference manuals now occupy over 22% of a book store's square footage, and account for 18% of total annual sales. This is a significant statistic considering that twenty-five years ago this kind of textbook did not exist.

It appears that these computer reference manuals are a particularly popular means of developing computer skills. Unlike classroom learning, these manuals provide a means to acquire skills independently at one's own pace, and at one's own convenience. These references vary in their format of instruction, and the nature of their content according to the targeted audience. User-guides typically provide an alphabetical resource to describe an application's specific functions, and are generally designed for the experienced computer user. Tutorial manuals offer a more structured curriculum, and are often used by first-time learners. The topics of these manuals can range from the

very simple (such as basic e-mail operations), to the very complex (such as Java-script programming).

Given the popularity of reference manuals for learning computer skills, one would assume that they are effective devices for acquiring computer skills. But given their varied instructional and visual designs, it is likely that one format is more effective than another. If this is the case, what constitutes a successful instructional and visual format that teaches concepts effectively without an instructor to verbally convey the information? How does the visual and instructional design enable learners to apply what they have learned to realistic tasks? What are the design principles necessary for ensuring that the information is useful, relevant, meaningful, and easy to comprehend?

These questions arose from an actual situation involving computer training for post-secondary interior design students, who were attempting to learn AutoCAD—a comprehensive computer drafting software application used widely in the design and drafting professions. The complexity of the software, and the short time students had in a classroom with an instructor, necessitated the creation of supplementary written materials to augment instruction, and to help students review, reinforce, and broaden their understanding of the AutoCAD program. It appeared that commercially-available manuals were not effective learning tools for these students, as they were too vast in scope, difficult to interpret, and irrelevant to the drawing needs of interior designers. As a result, the development of customized self-instructional learning materials became necessary—materials that were congruent with the design of the curriculum, centered on the specific needs of the interior design students, and clearly conveyed how to use AutoCAD.

Additional conditions warranted the creation of customized self-instruction materials. The first condition stemmed from the diverse abilities of students enrolled in the course: some students required a methodical demonstration of how to use AutoCAD, while others, especially those with an aptitude for working with computer technology, preferred to experiment with the software independently. Teaching these varied learners was complicated—students were either frustrated by their inability to keep up, or bored by the slower pace of instruction.

A second condition related to issues of time-table flexibility. The number of hours students were expected to spend in class and studio made it challenging for them to fully explore the AutoCAD software. If students were provided with suitable instructional materials to acquire AutoCAD skills independently, they would no longer be required

to be in a specific place, at a specific time, in order to learn the software. This, in turn, would enable instructors to focus primarily on those students who required individual attention.

The need to encourage students to learn AutoCAD independently suggested a need for the creation of a device to facilitate self-instruction. This would involve the creation of a product that brought together the disciplines of both instructional design and visual communication design, and testing and evaluating the results in an actual teaching and learning situation.

This project therefore blends two facets of my professional experience and education; ten years of experience in curriculum design as a full-time tenured instructor at Mount Royal College, and second, an awareness of visual communication and information design as a graduate student in the Master's of Visual Communication Design program at the University of Alberta.

This thesis is intended to demonstrate how visual communication design and instructional design are inextricably intertwined in motivating and enabling students to achieve desired learning outcomes—particularly as it applies to learning computer applications. It incorporates methodology necessary for the researching and testing of a designed product intended to satisfy the needs of its users. The research required a thorough understanding of the concerns and needs of the students and instructors involved in the AutoCAD course; an examination of theory relative to learning, visual communication design, and usability testing; a clarification of objectives which govern the development of the project; the creation of a series of prototypes which are tested in an actual learning situation; and finally, the revision of the prototype in response to test findings.

This paper is organized to reflect the steps undertaken in the design and testing process. The first portion of this document justifies the need for new instructional materials in the AutoCAD curriculum by providing background about the evolution of AutoCAD training and discussing the learning issues specific to the AutoCAD course in the Interior Design program at Mount Royal College.

The second portion of this document discusses the challenges and opportunities underlying the creation of effective instructional materials for acquiring computer skills. This research includes focus group discussions with former learners and current teachers of AutoCAD; an analysis of current materials devoted to teaching computer graphic software; an investigation of the AutoCAD application; and a literature

review concerning educational theory, visual communication design, and usability testing.

Based on this research, the third portion of this document defines objectives for the new instructional media by stating goals for both the design of the instruction and the visual format as they pertain to the needs of users and desired learning outcomes. These goals form the framework, for the development of the instructional media, which is discussed in the fourth portion of the document. This provides a detailed account of how the design of the instructional materials evolved, including a rationale for the resulting visual form and instructional content.

The final portion of this document concentrates on the testing process of the instructional media—the criteria for testing, the testing methods, and results generated. The results were subsequently analyzed and evaluated and the learning materials modified to respond to test results. The conclusion summarizes what was achieved, and the issues which remain to be explored.

This approach differs slightly from others concerned with the development of instructional materials in that it incorporates both curriculum and visual communication design as simultaneous activities, undertaken by a single design practitioner. It employs a research and testing process normally associated with usability testing to refine the product to its ultimate form. It is developed based on the specific learning needs of a defined user group. This project will thus serve as a model for the creation of instructional materials for computer applications that are functional, easy to learn, and satisfying to use.

PROBLEM DEFINITION

In order to convey design ideas and plans for construction coherently, architectural objectives must be communicated visually. Until the 16th century, this was accomplished directly on the building site where the mason, who also served as the architect, sketched design solutions using various implements and drawing surfaces. Designing and building were simultaneous activities—sketches were used to resolve details as they occurred, not to convey grand final schemes. During the Renaissance, designing and constructing evolved as separate activities in the creation of a building. With two different professionals now involved in the building process—the architect and the mason—a system for communicating design intent and construction methods through drafting measured, orthogonal drawings, was necessary. The architect drew the plans, and the mason assembled the building.

This tradition of visual communication continued into the late twentieth century. Until this time, architectural and design studios were furnished with drafting tables and pencils—the principal tools with which architects and designers expressed their ideas and construction intentions. In most offices, drafting technicians were responsible for translating architectural designs into technical drawings, yet architects and designers were also expected to be well-schooled in this practice. In fact, most junior architectural and design positions are devoted solely to creating technical drawings—since this is deemed a necessary initiation for understanding construction methods and processes.

With the development of the personal computer, in the early 1980s, Computer Assisted Drafting (CAD) software was introduced to the architectural industry. Its main selling feature was that drawings could be created with greater efficiency and precision, stored conveniently and efficiently, and recalled and revised more easily. This was the beginning of a design and drawing revolution in the interior design and architectural professions. As a result, drawing boards were soon eliminated to accommodate this new CAD technology.

The CAD software application of choice was AutoCAD, produced by *AutoDesk*. Written and designed by an engineer in California, the first of 17 versions was introduced in 1982. This vector-based program

was designed for use on an IBM personal computer platform utilizing the Disk Operating System (DOS) software that instructed the functioning of the computer through text-based commands. AutoCAD software was quickly adopted by the engineering disciplines, with the architectural and design industries following soon after. The acceptance of AutoCAD was not necessarily because the software was superior to other products, but because it was one of the first CAD applications to appear on the market. In order to ensure consistency in communication between the engineering and design professions, most offices standardized their computer drawing applications with AutoCAD. Currently, AutoCAD occupies over 70% of the market share of computer drafting applications. While there are many other CAD programs available, AutoCAD has remained the industry standard for computer assisted drafting applications.

The use of computer technology in the design profession has had a substantial impact on interior design education, specifically in curriculum pertaining to technical drawing. By the early 1990s, junior practitioners, who were normally initiated into the profession by being assigned to complete technical drawings, were expected to be proficient in the use of AutoCAD. As a result, interior design schools were pressured to offer courses in AutoCAD training. This was a very difficult enterprise, given that the technology was expensive (with each drawing station costing over $10,000.00 for both hardware and software), and the application was considered very difficult to learn. In order to teach AutoCAD effectively, most interior design schools offered a minimum of 64 hours of instruction. The faculty, who were not trained in computer drafting, were reluctant to surrender traditional design and drawing courses in favour of computer training. The debate between design schools and practitioners, concerning the inclusion of AutoCAD training in design curriculum, continued well into the mid-90s, until it became apparent that graduates without computer drafting skills were viewed as being less employable.

The Interior Design Program at Mount Royal College in Calgary, Alberta, was forced to respond to this new reality. In 1996, the program's Advisory Committee representing the local interior design profession, made it clear that learning AutoCAD was essential for entering the interior design industry. The accrediting body which governed interior design curriculum (Foundation for Interior Design Education Research—FIDER) stipulated that in order for any professional interior

design program to maintain its accreditation, computer drafting technology had to be integrated into its curriculum.

As a result, faculty and administration at Mount Royal College assembled the necessary technology and fashioned a course devoted to teaching students how to use AutoCAD. AutoCAD training was wedged into an existing course in the final semester of their two-year diploma program, a course which focussed on construction fundamentals. The typical format for the four-hour class included demonstration and practice for a series of commands, with the final hour devoted to completing a specific assignment encompassing the commands taught for that day. The course was conducted for four hours each week over a 16-week period, and taught to a cohort of 25 students.

In time, the AutoCAD curriculum evolved and became more sophisticated. By 1999, the interior design program expanded from a two-year diploma program to an eight-semester, Applied Bachelor Degree Program. As such, AutoCAD was offered as a separate course in the fourth semester of the program. This course was intended to teach basic skills in AutoCAD such that students would be able to draft a complete set of architectural drawings within a 15-week semester.

Although students were able to achieve course objectives, they did so with varying degrees of success and satisfaction. AutoCAD is an extremely complex and comprehensive math-based program, written for, and by, engineers. The language it employs, and the drawing interface it provides, are more suited to linear and logical processing—an approach foreign to that taken by most interior design students. As such, students found AutoCAD's interface and mode of operation to be contrary to their normal practice of manual drafting. They encountered difficulties in making the transition from drawing directly on paper to drawing in infinite space on a computer screen using mathematical equations. This was frustrating and time-consuming for students, who were already capable of creating drawings efficiently on paper. Students were not convinced that the effort to learn this software was worth the time and strain, and therefore felt little motivation to learn the software.

Another factor which appeared to impair learning was the diversity among the students with respect to skill level and aptitude for learning computer applications. Experienced students were frustrated with perceived lags in time, and inexperienced learners were anxious about the course moving too quickly. When students encountered errors or technical challenges, their preferred method for seeking resolution was

to solicit the instructor, rather than trying to remedy problems on their own. As pressures for time increased, their resolve for working out problems independently diminished.

The lack of suitable learning materials, written specifically for students of interior design, compounded the frustration in learning AutoCAD. Until this point, curriculum and course materials were written by experts in AutoCAD and directed toward technical training in the engineering professions. These manuals were vast in the scope of the content and written for an audience that included surveyors, cartographers, engineers in the structural, civil, mechanical and electrical disciplines; architects; interior and industrial designers — any professional involved in drafting plans. These manuals were unapproachable, difficult to interpret, and daunting in their appearance. Many of these texts were over one-thousand pages in length, with command functions presented alphabetically, rather than sequenced in a logical order for the procedures required to create a drawing.

The manuals which had an instructional approach, were still oriented towards a very broad user-group, and therefore, held little relevance for the specific drawing needs of interior designers. These manuals were text-oriented, and failed to translate the complex and technical language associated with AutoCAD effectively. More time was required to interpret meaning, than to perform operations.

The few learning materials available on the market for interior design students were written by American authors and did not relate to Canadian drawing standards with metric measurements. While these books did have drawing exercises that were relevant and applicable to interior designers, neither the drafting standards nor the curriculum were suited to the needs of the interior design program at Mount Royal College.

The lack of adequate teaching materials created a considerable challenge for AutoCAD instructors at MRC. To address this concern, supplementary learning materials were created. Prior to each class, handouts were generated to cover the commands introduced in the lesson for that day. These notes outlined the purpose of the commands and how they were applied. They also contained step-by-step instructions to practice each of the commands taught. The handouts evolved into a manual which was used in subsequent AutoCAD courses.

While this manual was somewhat rudimentary, it at least coincided with the curriculum structure of the Mount Royal College Interior Design AutoCAD course. It was intended to supplement learning and

to serve as a resource for completing assignments outside of class. Its format followed the activities in the lecture and lab by providing introductory information, a series of step-by-step practice exercises, and a small assignment incorporating the commands covered in class. Information regarding the functioning of the software was clarified by written text. Rather than providing visual cues to explain software idiosyncrasies, these were clarified by statements such as, 'you should see your cursor move upward.'

After a trial period of four years, it became evident that the manual was not being used as intended. Rather than referring to the information in the manual to clarify and refresh concepts, students still turned to the instructor. It appeared that the lack of visual images in the notes made it both difficult and time-consuming to interpret the content. Therefore, few students used this resource outside of class to assist them in their project work, or as a means to better understand AutoCAD.

In recognition of this situation, it was clear that this initial manual needed to be changed. It was thought that a revised version of this manual could potentially serve as a resource that encouraged self-initiated learning, thereby freeing instructors' time to provide individual assistance where it was needed most. It would serve as a reliable resource, to which students could refer, in the event that an instructor was unavailable. It would also provide students with information specific to standards of the Interior Design Program at Mount Royal College and the Canadian Construction Industry.

The following section provides an in-depth analysis of the strengths, weaknesses, challenges and opportunities inherent in developing instructional materials for learning AutoCAD. The problem was examined based on information from former learners and instructors involved in the AutoCAD course at Mount Royal College; an analysis of learning materials devoted to computer self-instruction; the idiosyncrasies specific to the AutoCAD application; and a literature review based on theories pertaining to learning, visual communication design, and usability testing.

PROBLEM ANALYSIS

In order to understand fully the problems inherent in teaching AutoCAD to interior design students, and to learn more about the strengths and shortcomings of available instructional materials, a series of exploratory and analytical exercises were undertaken. This investigation was conducted to gain insight into:

- the particular needs of AutoCAD learners and instructors
- the objectives of the AutoCAD course in an interior design program
- the content and style of various self-instruction computer guides
- the general mechanics behind the AutoCAD software application
- the current thought in graphic design research methodology, technical writing, learning theory, and visual communication design

The analysis of concerns and challenges pertaining to instructional materials for computer applications consisted of a series of steps. To test assumptions based on experiences learning and teaching AutoCAD, focus group discussions were held with former students and current instructors of the AutoCAD curriculum. These discussions were followed by a survey of available teaching materials for computer applications, as well as an analysis of the mechanics of the AutoCAD program. Finally, a review of literature concerning graphic design research, visual communication design, technical writing, learning theory, and usability testing was conducted. The overall analysis of the design problem was completed within a time-frame of eight weeks to ensure that project production deadlines could be met for usability testing.

What follows is a synopsis of the activities and findings which resulted from analyzing the various issues involved in the independent teaching and learning of a computer application.

Experiences of teaching and learning computer applications

Despite the shortcomings inherent in generalizations based on personal experiences, it was useful to analyze them consciously and to acknowledge their corresponding assumptions. The purpose of reflecting on experiences in gaining competency and teaching AutoCAD was to

question initial assumptions regarding how computer software applications were learned.

The following are the assumptions, based on personal experiences and observations of students and instructors at MRC, which were formulated while learning and teaching AutoCAD.

- structured learning seems to clarify complex concepts more readily than software user-guides
- assignments that are simple, yet relevant, appear to keep learners inspired and motivated to continue learning
- AutoCAD skills are retained longer with frequent and ample practice
- curriculum pacing is often disrupted by disparity in students' computer skills
- disparity in computer skills among students is often extreme
- independence from an instructor appears to grow as comfort level with software increases
- students generally turn to an instructor for assistance before consulting reference materials
- errors and other technical challenges seem to impair student resolve for problem-solving

Former-learner focus groups

In order to test these assumptions generated from personal teaching and learning experiences, and to acquire a better understanding of the students' assessments of the AutoCAD curriculum and instructional materials, a focus group involving former learners was established. The aim was to understand the specific needs of these learners and their impressions of both the current instructional materials and the curriculum.

Seven interior design students, who had completed the AutoCAD course under the guidance of other instructors, volunteered to relate their learning experiences. To facilitate a comfortable and casual discussion, this meeting was held in an informal setting, at a time when the students were not constrained by school deadlines. Students were assured that the information they provided would be kept confidential, and that the discussion was being conducted to improve upon the instructional materials of the current AutoCAD curriculum.

The session began with the students completing a prepared questionnaire which asked them about their opinions regarding course content, course organization, instructional materials, and their degree of

satisfaction with the course overall. The intent of this questionnaire was to provoke analysis uninfluenced by peer discussion. These questions later formed the basis for an open conversation among the group, and included the following questions:

- Do you think the AutoCAD course taught you how to create a standard set of architectural drawings using AutoCAD?
- Did this course encourage you to 'learn how to learn'?
- What worked well, and what could have been improved with respect to the pace of instruction, the concepts taught, assignments and exercises, content organization?
- How should student work be better assessed in order to foster growth and comprehension of course material?
- In your opinion, what type of instructional media would be helpful for encouraging you to better understand the principles of AutoCAD?

Students also provided information about their age, level of computer proficiency before and after the AutoCAD course, and their feelings about computer technology in general.

These students ranged in age from 23–33, and were all female. 40% rated their computer experience as 'beginner' prior to entering the AutoCAD course, and 60% rated their experience as intermediate. All but one student felt that their computer expertise had improved upon completion of the course. When asked to rate their feelings toward computer technology, 80% of the students 'liked' it, 10% of the students 'loved' it, and 10% of the students were 'indifferent'.

The concerns which garnered the most attention were as follows:

- students felt hindered by lack of time to complete assignments
- pace of instruction did not accommodate the various learning speeds of students
- some students felt the material was easy, others felt it was difficult
- instructors or lab assistants who knew AutoCAD were not available after class hours
- course materials did not provide enough information to promote independent learning
- course materials were difficult to interpret and information was hard to find
- concepts pertaining to 'printing', 'dimensioning' and 'formatting styles' were unclear and difficult to comprehend
- computers were difficult to access with approaching deadlines

Instructor interviews

To gain perspectives regarding the teaching process, two instructors involved in the AutoCAD course were consulted. As with the student focus groups, prior to commencing discussion, the two instructors were asked to complete a questionnaire concerning course objectives, the strengths and weaknesses of the current curriculum, and students' success and satisfaction relative to the course objectives. This was done to allow instructors to formalize their opinions prior to conveying them.

Subsequent discussions focussed on re-evaluating course objectives, and determining how to achieve the objectives through course content, curriculum structure, and accompanying instructional materials. Instructors provided the following observations:

- students found concepts of printing with 'paper space', dimensioning drawings, and formatting styles to be beyond their scope, particularly as deadlines approached and pressure for time increased
- students need to be more aware of drawing standards particular to both Mount Royal College and the Canadian construction industry
- instructors were overwhelmed by student requests to help rectify errors and technical difficulties
- students need to become resourceful, willing to take risks, and to develop independence from instructors
- repetition was required to reinforce command functions
- students needed instructional media to reinforce concepts taught in class

Instructors also indicated that they valued the content and organization of the current curriculum, and contended that instructional materials, if improved, could serve as guided instruction benefiting both beginner and advanced students by encouraging them to establish their own pace for learning. They felt that this would alleviate the pressure on instructors to be available for each student as problems arose.

Analysis of computer manuals for graphic applications

In order to create appropriate instructional materials to promote independent learning of AutoCAD, an analysis was conducted of commercially-available self-instruction computer manuals. This analysis included only those manuals that dealt with graphic applications, and those that served as instructional guides for AutoCAD. The manuals pertaining to computer graphic applications were selected on the basis of their

complexity relative to AutoCAD. The intent was to examine format, content organization, presentation of information, and methods of information access and retrieval. The kind of visual imagery and use of graphic elements were also examined. This analysis helped to determine common features of the software learning guides, and the features which seemed to promote better comprehension of complex concepts.

Manuals which were successful had the following characteristics in common:

- table of contents was clear and well-organized
- information was structured from the general to the specific, and headings made evident the *function* of the command, rather than the *name* of the command
- content was logically sequenced from basic to advanced features
- textual information was clear and stated succinctly
- layout was simple, logical, and easy to follow
- graphic elements were minimal and did not distract from the information
- typefaces were clear and easy to read
- book was within an affordable price range
- images were easy to interpret and appeared simple to achieve

Manuals which were less successful had the following characteristics in common:

- book was too expensive
- book was awkward to handle, particularly when working at a computer. These books tended to be large, heavy, and difficult to keep open
- organization of content was difficult to discern
- heading types were too numerous, rendering it difficult to interpret their level of importance and relevance
- information was hard to find
- jargon was extensive
- content was text-heavy
- page layouts were unpredictable and inconsistent
- images and exercises lacked relevance and interest
- too much emphasis on graphic embellishment, which distracted from the content

Analysis of AutoCAD commands and functions

In order to convey clearly the content, structure, and workings of the AutoCAD software, an analysis of its features and processes of

operation was undertaken. The following is an assessment of the logic and structure of the AutoCAD application.

AutoCAD is an intellectually-demanding vector-based drafting program that functions through a system of mathematical equations. A basic understanding of polar angles (angle degrees) and Cartesian coordinates is required simply to draw a straight line. For instance, in order to draw a 36" line upward, one must enter the following data at the command prompt: *@36<90*. Unlike manual drafting, computer drawing is conducted within infinite space, and all objects are drawn at actual size. This differs from manual drawing, where objects are drawn at a reduced scale so that they fall within the parameters of the paper size.

In order to draw a line, or accomplish any other task such as *erase*, the appropriate command must first be activated. Upon activation, additional input is required for the desired effect to take place. In some instances, such as the *polar array* command, up to ten different specifications are required before the desired array is achieved. Specifications can be given either by typing input on the command line, by using a mouse to direct the cursor on the screen, or by specifying information within a dialogue box if one exists for that command.

Commands can be activated in a variety of ways: by clicking icons, typing command names on the command line, highlighting menu drop-downs, or by typing quick-key shortcuts. Because of its Disc Operating System (DOS) origin, all AutoCAD commands can be activated by typing in the name of the command. By contrast, not all commands can be prompted through icons, quick keys, or through the menu. Again, because of DOS origins, command names are abbreviated, sometimes to the point of being unintelligible. For instance, to activate the *layers* command, one must type '*ddlmodes*' at the command prompt.

AutoCAD commands can be categorized according to their purpose. These categories include drawing objects, using commands such as *line, circle, rectangle,* and *dimensions*; modifying objects, using commands such as *erase, copy, move, stretch*; or assisting the drawing process by using commands such as *drawing layers, object snap, grids, zoom,* and *polar tracking*. Some functions are more complex, but essential to the drafting process. These include *printing, dimensioning and formatting drawing styles*.

The commands within the categories of draw, modify, drawing aids, style formatting, and printing, can be further distinguished by their

necessity for creating architectural drawings. For instance, the *break* command is a modifying command, and used to create a gap in a line or to break a line segment at a specific location. However, this can also be accomplished by using the *trim* command—a modifying function which has wider applications. Therefore, *trim* could be considered an essential modifying command to know, while *break* is less so.

The intent of this analysis was to help determine which commands are necessary for architectural drawing, and the logic by which these commands are organized—thereby clarifying the content of the curriculum, and how it might be structured.

Literature review

Due to the interdisciplinary nature of this design problem, research literature pertaining to learning theory, visual communication design, and usability testing was reviewed. Learning theory readings focussed on experiential learning, constructivism, and cognitive architecture. This information was supplemented by relevant literature in the area of typography, information design, and technical communication. Writings pertaining to design methodology and usability testing were reviewed to address the iterative nature of this design problem.

Learning theory

Significant research done to date in the area specific to learning computer applications has been conducted by John Carroll, professor of Computer Science at Virginia Tech University. In his book, *The Nurnberg Funnel, developing minimalist instruction for practical computer skills,* Carroll presented principles for creating effective learning devices for helping new learners acquire skills in operating a computer. Carroll's investigation in this area began during his time as head researcher with IBM, when he was charged with the task of examining human-computer interactions. His research was conducted in the early 1980s, at a time when personal computers were beginning to appear on desks throughout the North American workforce—and when employees, with little or no exposure to computer technology, were expected to become proficient in their operation. During his research to make computer interfaces more usable, Carroll became curious about how first-time learners eventually acquired computer skills. This curiosity was precipitated through informal observations that instructional materials of that time were not effective tools for teaching people to become productive computer users. Carroll called these manuals 'systematic', due to their behaviourist leanings toward stimulus/response learning.

In other words, users were expected to learn by following rote, step-by-step instructions in order to complete a task. What he observed however, was that when asked to repeat a task on their own or to transfer their learning to another application, most learners were unable to do so.

Consequently, Carroll developed an interest in understanding how learners best acquired new computer skills. The first series of tests Carroll conducted was to determine the efficacy of the instructional materials that were used to teach a word-processing application. These studies were conducted with 'real users'—individuals who, due to varying job circumstances, were required to learn basic word processing skills.

Observed in a setting which closely resembled a workplace training situation, the research participants were asked to use a systematic-style learning manual to acquire basic word processing skills. As they progressed through the instructional materials, they were asked to think aloud through their actions by expressing what they were doing, and why they were doing it. Researchers were not permitted to assist, only to inquire as to their strategies for learning. Instructions, and subsequent actions and observations, were recorded as the participants progressed through the instructional materials.

What Carroll consistently found was that although learners complied with the step-by-step instructions, they did not understand the reasons for them, or the ultimate aim of the instructional sequence. Although these instructions appeared simple, they did not appear to be successful in promoting computer skill development. Carroll observed that the only time learners appeared to interpret deeper meaning into the functioning of the software, was when they attempted to recover from errors. It was during this phase that learners disengaged from the required steps, looked up to their monitors, and analyzed what had gone wrong in order to remedy the situation. He recognized that although errors were debilitating, they were also sources for valuable learning experiences. In fact, "...error is best regarded as inevitable and perhaps intrinsic to human learning." (Carroll 1990, p. 9).

Unfortunately, errors also obstructed learner progress. Although the step-by-step instructions were simple and direct, they failed to anticipate or accommodate reader misinterpretation, and therefore provided little means for learners to diagnose and recover from their errors. This left many learners in a state of frustration, and diminished

their level of trust with the instructional materials. This aggravation was compounded when learners did not fully understand where the instruction led, since the goals of the systematic manual were neither explicit, nor meaningful to the user—what they were being asked to do was not what they wanted to do. For instance, these manuals often directed learners to initiate a document by creating and naming a file through a complicated series of steps. This process, as Carroll observed, differed greatly from their normal routine of initiating a document which involved engaging a piece of paper in a typewriter and establishing margins. (Carroll 1990, p. 4).

Carroll surmised that the systematic materials, offering only rote instructions, failed to facilitate computer proficiency for a number of reasons. First, the instructional materials did not acknowledge learners' propensity for questioning objectives or seeking meaning from the instructions. Second, the manuals provided little assistance for helping learners to diagnose errors or recover from them. Third, the manuals did not inspire or motivate learners by providing them with meaningful, relevant goals to achieve. Finally, the tasks and goals of the instruction bore no resemblance to prior manual skills, leaving learners both frustrated and confused as to how this new technology would best serve them. (Carroll 1990, p. 71).

Based on these observations, Carroll concluded that in order for instructional materials to be successful in promoting computer competency, they must engage learners as quickly as possible. This, he stated, should be accomplished by emphasizing task-oriented activities relevant to the learners' needs, and de-emphasizing verbiage. Further, he suggested that manuals should provide learners with guidance in recognizing when and how errors occur, and directions for correcting these errors.

Based on these heuristics, Carroll designed the *Minimal manual*; a resource inspired both by his observations of computer learners, as well by the humanist, experiential learning theories of John Dewey, Jean Piaget, and the constructivist learning philosophies of Jerome Bruner. This manual was designed recognizing that knowledge is not merely the acquisition of information, but the interpretation of experiential events through observation and analysis. It was developed based on observations that learners adopt their own goals and strategies for learning, and learn best through experience that is meaningful and relevant. (Carroll 1990, p. 78).

Carroll called his manual 'minimal', because it did not contain anything that could distract learners from working on meaningful tasks. It was proposed that by avoiding the clutter of superfluous information, such as a description of how the computer system operated, learners would become proficient in a shorter time frame. Learning was to be facilitated through 'guided exercises' that issued specific tasks (such as typing a memo) accompanied by tips and suggestions to fulfil that task. So rather than providing rote, prescriptive directions to learn a series of steps—such as 'place the cursor here, type this character here, hit the return key'—the manual provided an objective for students to achieve, and encouraged learners to, 'try this, observe what happens here, and watch out for this'. Through exercises such as these, Carroll anticipated that learners would inadvertently discover such things as how to manipulate the cursor or highlight characters, and therefore draw their own conclusions and connections as to how the application functioned. These 'real-life' activities were intended to sustain motivation for learning, and encourage learners to seek out additional information regarding the computer application as needed.

In recognition of what Carroll called the 'paradox of sense-making'—that in order to make sense of something, something must first be learned; and in order to learn something, one must first make sense of something—the minimal manual still provided the necessary groundwork for becoming functional. The primary lessons focussed on skills that were familiar to the user, such as typing, as opposed to file creation and retrieval. These exercises were formatted in terms of guided exploration, as opposed to systematic instruction. Acknowledging Bruner's notion of 'constructing knowledge', Carroll sequenced the instruction so that the fundamental skills were mastered (such as highlighting a set of characters) before moving on to more advanced skills (such as formatting text). (Carroll 1990, p.77). Carroll recognized from earlier testing that learners not only desired structured learning, they needed that structure to help them make sense of what they were learning. (Carroll 1990, p.136).

After a series of tests and redesign, the *Minimal manual* proved to be far more successful than its systematic predecessors. Carroll measured this success by comparing the amount of time taken to learn a skill (such as learning to type and format a document) and time and accuracy in completing a related assignment. Those given standard, step-by-step instructions not only took considerably longer to learn the task, they also performed significantly poorer on the subsequent

assignment. The *Minimal manual*, concluded Carroll, "seemed to help participants learn how to learn." (Carroll 1991, p. 166).

In recent writings *(Minimalism beyond the Nurnberg Funnel*, 1999), it was apparent that the *Minimal manual* garnered both its detractors and supporters. Detractors were primarily concerned that the minimalism approach was too brief and forced the user to adopt a trial-and-error approach to learning; that it was only applicable in simple domains; and had no theoretical foundation. (Carroll 1998, p. 56). Carroll and others responded to these claims by elucidating subsequent empirical testing to demonstrate that 'minimalist instruction is a robust and reliable method for writing documentation that out-performs most conventional manuals'. (Carroll citing Draper and Oakley, 1990).

Clarifying the intent of the minimal manual, Carroll offered the following principles and heuristics for the design of computer instruction manuals:

Principle 1 *Choose an Action-Oriented Approach*

- provide an immediate opportunity to act
- encourage and support exploration and innovation
- respect integrity of users activity

Principle 2: *Anchor the Tool in the Task Domain*

- select or design instructional activities that are real tasks
- create components of instruction that reflect the task structure

Principle 3: *Support Error Recognition and Recovery*

- prevent mistakes whenever possible
- provide error information when actions are error prone or corrections difficult
- provide error information that supports detection, diagnosis, and recovery
- provide on-the-spot error information.

Principle 4: *Support Reading to Do, Study, and Locate*

- be brief, don't spell out everything
- provide closure for chapters

(Carroll 1998, pp. 21-41).

This 'less is more' approach to learning was also prevalent in the writings of John Sweller, a cognitive scientist from the University of New South Wales, Australia, who devoted his research to understanding the role of cognitive architecture in developing expertise in technical areas. Sweller, a proclaimed cognitivist, applied a more rational and empirical approach to understanding how one learned, particularly

in non-discursive areas such as mathematics, physics, and computer programming.

Although both Carroll and Sweller supported constructivist learning and the reduction of information to support active learning, they differed in their rationales. Carroll stressed that information should be brief in order to encourage meaningful learning through inference-making, and to allow learners to develop expertise by working on tasks that were relevant and immediate. Sweller concurred that too much information hindered the learning process, but only because humans have a limited capacity in their working memory to process information. In fact, Sweller found that when learners were forced to make inferences and solve problems, their ability to develop effective patterns for solving problems and developing expertise, was greatly impaired.

The basis of Sweller's argument stemmed from G.A. Miller's research (1956) which examined the limited processing capacity of memory. This study demonstrated that test subjects could recall only seven numbers (plus or minus two) from a series of numbers presented to them. Peterson and Peterson expanded upon this study in 1959, and determined that not only was memory limited in terms of its capacity, but also in the amount of time it was able to retain information. They reached this conclusion after observing that test subjects, distracted for a short period of time, were able to recall only three digits from a series of numbers to which they had been exposed. From this, Sweller concluded that our capacity to retain and process information was extremely limited, estimating that no more than two to four elements could be preserved in memory. (Sweller 1999, p.4).

This particular segment of our memory (formerly referred to as short term memory) was described as the 'working memory'. According to Sweller, it is that portion of our cognitive structure that is responsible for temporarily holding and processing information. Long term memory on the other hand, is that portion of our cognitive structure that stores the information that the working memory has resolved and categorized in an orderly fashion. Once information has reached this state of being congruent and implicit, it is regarded as a 'schema', and is stored in the long term memory. Sweller clarified a schema as, '...a cognitive construct that permits us to treat multiple elements of information as a single element categorized according to the manner in which it will be used." (Sweller, 1999, p.10). He asserted that by creating schema, humans were able to process more information, since information was no longer in the form of disparate elements

subject to comparison and contrast, but a unified whole. This was referred to as schema formation, and considered essential for building knowledge.

By forming schemas, Sweller contended that humans expanded their expertise for resolving problems. He cited the experiments conducted by Chase and Simon (1973) and later by Simon and Gilmartin (1973) who demonstrated that master chess players were able to store up to 100 000 different game-board configurations in their long term memory. By being familiar with the workings and patterns of a chessboard through repeated exposure to the game, master chess players were able to quickly recall known and successful strategies when confronted with various game-board configurations. Sweller contrasted this to the playing strategies of a novice chess player. Not only would the novice need to learn the various moves of each of the pieces, but he or she would also need to consider the consequences of each move in a variety of scenarios. By cluttering their working memory with learning the pieces of the chessboard and understanding their interactivity, novices' abilities to resolve problems were considerably slower and less refined. Thus, Sweller concluded, "Skilled intellectual performance comes from the ability to recognise appropriate circumstances and the actions required by those circumstances. This ability comes from long deliberate practice that permits appropriate cognitive structures to be acquired and held in long term memory." (Sweller 1999, p.10).

Sweller called this unconscious application of a known rule or strategy, 'automation', and deemed it necessary for developing expertise in problem solving. This, he noted, was especially important in technical domains. But rather than developing automation through problem-solving and making inferences, as recommended by Carroll, Sweller proposed that this intellectual process placed too great a demand on the working memory, and wasted precious cognitive space for establishing schema and automated strategies. Rather, he suggested that new learners be shown successful strategies, rather than forcing them through trial and error exercises. These strategies for successful problem-solving were best illustrated through what Sweller called 'worked examples'—a series of exercises showing the evolution of how problems were resolved.

Sweller demonstrated the learning benefits of these worked examples in a series of tests involving algebraic and physics theorems. In these tests, students who learned through worked examples

demonstrated greater competence in solving problems in a shorter period of time than their counterparts who were provided a series of problems to gain practice. Where this learning strategy was not successful, was in the domain of geometry. Sweller hypothesized, and eventually concluded through additional testing, that the worked examples complicated the working memory by containing a diagram with accompanying text. These types of diagrams forced the learner to read and interpret a geometric theorem, and integrate it with a corresponding diagram in order to fully understand the worked example. Sweller referred to this symptom as the 'split-attention effect'—a condition whereby two disparate pieces of information must be separately understood and simultaneously connected.

Therefore, to avoid the split-attention affect, which placed additional stress on the working memory, Sweller suggested that text should be integrated with the image. Using different worked examples containing diagrams pertaining to blood flow, electrical circuitry, numerical-control programming, and geometric theorems, Sweller demonstrated through both laboratory and realistic conditions that, "Appropriately designed worked examples resulted in enormous improvements in learning and problem-solving compared to conventionally structured examples." (Sweller 1999, p. 101). In fact, in one experiment involving numerical-control programming, students exposed to integrated diagrams took 50% less time to assimilate the information, and scored significantly higher on test problems than students exposed to diagrams where text and image were not coordinated. (Sweller 1999, p. 93).

In addition to split-attention diagrams, Sweller also found repetitive information to be problematic for increasing strain on the cognitive load. He referred to this as the 'Redundancy Effect'. Redundancy was considered to be information that was repeated using different syntax, or used in addition to an integrated diagram. It required reading, comprehending, and comparing against other information in order to determine its association and relativity. Instead of reinforcing information then, repetitive information impinged upon the cognitive load thereby decreasing its efficiency for processing information.

Sweller stressed the importance of acquiring schema and automation in order to develop successful strategies for solving technical problems. This, he concluded, was best achieved by having students study worked examples—a cognitive activity that placed minimal strain on the working memory, and increased mental capacity for developing

schema. Instructional materials played an equally important role in minimizing cognitive load, by avoiding information that was redundant or discordant in its presentation of text and associated images. Both Carroll and Sweller contended that learning cognitively demanding subjects, such as computer applications, would be facilitated if instructional materials were brief and free of redundant content.

However, by concentrating solely on the form of the instruction to achieve successful learning experiences, both Sweller and Carroll may have disregarded possible variables presented by the learners themselves. In other words, would their proposed format of instruction work for all learners? More specifically, would a learner's prior knowledge, motivation, and strategies for perceiving and processing information affect the learning process, regardless of the domain of instruction?

These concerns were echoed by Dorothy Cady, in her book *Bullet proof documentation, creating quality through testing*, and by Edmond Weiss, in his book entitled *How to write usable user documentation*. Both of these authors and experts in technical writing concurred with Carroll that effective teaching materials were those that helped learners become productive early in the learning process. They supported Sweller's notion that readers should be prevented from looping back and forth to retrieve information in order to assemble a coherent understanding. However, where they differed from these two theorists was in stressing the importance of understanding user needs in the design of instructional materials. As Weiss stated,

> ...the process must be driven by the particular characteristics of the users and operators and their peculiar interests in the system, rather than follow a one-size fits all standard for user publications. (Weiss 1991, p. 44).

Perhaps one of the biggest proponents for emphasizing the need to understand learner styles for developing meaningful instruction, was educational theorist David Kolb. He felt that by understanding how one learns, curriculum could be struck in a way that enhanced each individual's potential for acquiring and interpreting information. In his book, *Experiential learning—experience as the source of learning and development,* Kolb stated,

> If the education process begins by bringing out the learner's beliefs and theories, examining and testing them, and then integrating the new, more refined ideas into the person's

> belief systems, the learning process will be facilitated. (Kolb 1984, p. 196).

On the basis of this notion, Kolb sought to understand the nature of intelligence and how it developed. He was interested in knowing how information was analyzed, interpreted and adapted in order to accommodate to changing environmental circumstances. Kolb proposed that learning was, "a continuous process grounded in experience. Knowledge is continuously derived from and tested out in the experiences of the learner." (Kolb 1984, p. 26). Like Carroll, Kolb cited the work of Jean Piaget, Jerome Bruner, John Dewey as well as other humanist scientists such as Carl Rogers, Abraham Maslow, Erik Erikson and Carl Jung as being instrumental in the development of experiential learning theory. Common to each of their theories was the notion of constructing motives, beliefs, attitudes, intelligence, and values through the interpretation of experiential events.

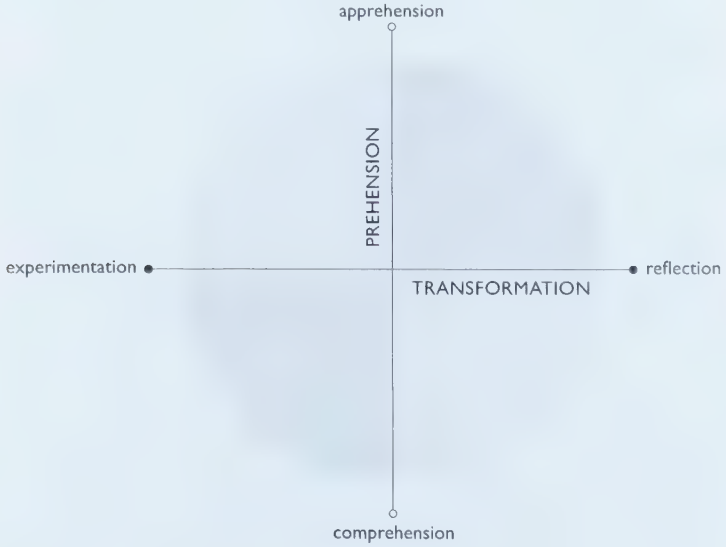
In particular, Kolb acknowledged the work of Jean Piaget for providing a framework for understanding the relationship between experience and the development of intelligence. By observing the intellectual growth of children, Jean Piaget was able to determine four distinct phases of development. In the initial phase, from age 0–2, Piaget found that children were essentially receptors of the concrete, external world. From age 2–6, children developed the capacity to reflect upon their environment and the information they absorbed through their various senses. By age 7 and up to age 11, children were able to create abstract representations of their observations, and interpret their reflections in symbolic ways. They were no longer reliant upon direct, concrete experience to understand their world, but incorporated past experiences and their reflective prowess to induce potentialities. Between ages 12 and 15, youngsters were adept at developing and enacting strategies based on theories acquired in the previous stage.(Kolb 1984, p. 23).

According to Kolb, adults, when confronted by a new situation, also interpret their environment in much the same way—however, their system for learning is not regimented in terms of isolated phases, but rather in terms of a simultaneous interaction of all phases. Essentially, Kolb described adult learning as involving two processes: that of acquiring information, which Kolb referred to as *prehension*, and that of processing information, which Kolb referred to as *transformation*. How one gathered and transformed information differed depending upon the learning style of the individual, and the context and content of the information being processed. Kolb maintained that "The central idea

here is that learning, and therefore knowing, requires both a grasp or figurative representation of experience and some transformation of that representation." (Kolb 1984, p.42).

Kolb stated that a dialectic relationship existed in the act of gathering, or prehending information, as well as in the act of transforming information. In the act of prehending information, one grasped information either instantaneously and wholly through apprehension of sensual experiences, or simultaneously and partially through comprehension of symbolic concepts. By apprehending information, one perceived the world in its concrete, objective state, by relying on the senses to gather information. Kolb referred to this form of prehension as *apprehension*. *Comprehension* on the other hand, was the act of grasping information through a more mindful process that involved the analysis of symbolic, abstract concepts. Therefore, at one extreme of prehension, information was acquired through feeling, at the other extreme, through thinking.

The act of transforming this information was also dialectic- either internally through reflection and observation, or externally, through active experimentation. However, Kolb maintained that both processes were essential for making meaning of information, and therefore, like the two states of prehension, existed in a state of dialectic opposition. Kolb clarified that neither process of acquiring or transforming information was better, or more evolved, than the other. In fact, all were necessary and 'equipotent' for prehension and transformation. (Kolb 1984, p.52).



Kolb also recognized that each individual grasped and transformed information in a way that was unique to his or her physiological, emotional, social and intellectual constitution. Combining Piaget developmental theory and Jungian psychology of personality types, Kolb categorized the various learning profiles by examining how people perceived and processed information. Those that acquired information through their feelings, generally preferred concrete experiences (CE) for establishing generalizations about their environment. These individuals were likened to artists who used intuition and personal feelings to understand a situation. This was in contrast to individuals who grasped information cognitively through abstract concepts (AC). These individuals used logic, ideas, and theories to formulate their understanding of the world. In addition, there were those with an inclination towards reflective observation (RO). These individuals come to understand a situation by ingesting and synthesizing as many possible alternative views into a consolidated whole. They were more interested in understanding a situation, than generating results. This style of learning was in opposition to those who learned through active experimentation (AE), where learners were more interested in what really worked, versus what the theory stated should work. As such, they generally learned from applying information in a practical way. (Kolb 1984, p. 68).

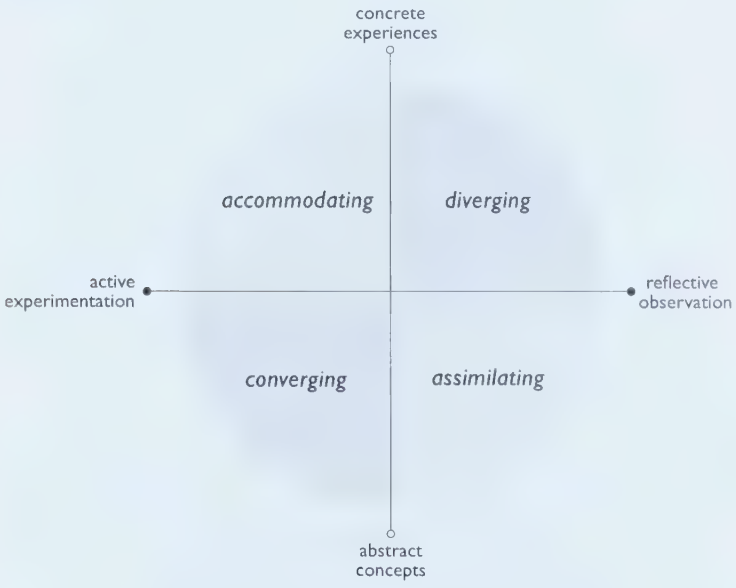
Each of these modes of acquiring and processing information worked in combination to further distinguish how individuals made meaning of their environment. In other words, information could be absorbed through concrete experiences (CE), and processed by reflection and observation (RO), or by active experimentation (AE). Conversely, others would use abstract concepts (AC) to be tested through active experimentation or understood through reflective observation. Kolb distinguished the perceiving/processing relationship as follows: Those who perceived through concrete experiences and transformed through reflective observation (CE/RO) were referred to as *divergers*, because these individuals viewed concrete experiences from many different perspectives. These individuals excelled at generating many ideas, tended to be imaginative, and enjoyed associating with people.

At the opposite end of the spectrum, were the *convergers*, those who perceived through abstract concepts, and transformed through active experimentation (AC/AE). These people preferred to use theories and concepts to make decisions and solve problems. Convergers

preferred singular, correct solutions, versus a multitude of probabilities. Their strength lay in working independently on technical tasks.

Assimilators were individuals who preferred to reflect and observe the connection between various abstract or conceptual ideas (AC/RO). Their agenda was to generate models that were theoretically sound, and hence, were more interested in their validity, than their applicability. Like convergers, these individuals were less people-oriented, and preferred to work on their own.

Kolb identified the *accommodators* as opposites of assimilators. This group perceived information through concrete experiences, and transformed them through active experimentation. (CE/AE). They enjoyed working with people, and getting things done. They were referred to as accommodators, because of their ability to adapt quickly to a given situation. They relied on people, not facts, for their source of information, and tended to solve problems in an intuitive, trial-and-error fashion. They emphasized generating results, not analyzing outcomes.



Kolb declared that each of these learning strategies was incomplete, and must therefore be synthesized in order to create a 'unified, adaptive process'. He elaborated by saying action based on 'gut feeling' was impulsive, reflection based on theories was impractical. (Kolb 1984, p.66).

In order to determine individual learning preferences, Kolb developed the *Learning Style Inventory* (LSI). This test determined

how one was inclined to learn: either through concrete experiences (feeling), reflection and observation (watching), abstract concepts (thinking), or active experimentation (doing). It further assessed whether an individual was divergent, assimilating, convergent, or accommodating with respect to their learning profile. In a number of studies, Kolb was able to demonstrate the consistency of learner profile characteristics relative to the areas of study that learners chose to pursue. In other words, a divergent learner often enrolled in courses which embodied feeling/observing activities, such as dealing with people, working in groups, and listening to others. By contrast, convergent learners were often found in courses that involved thinking/experimenting activities, such as analyzing quantitative data, organizing information and testing new theories and ideas.

Although it appeared that various areas of study were more conducive to specific learning styles, Kolb felt that students should be encouraged to approach learning in a way that encompassed all aspects of prehending and processing information—regardless of the area of study. Even though a domain may be technically oriented—as is the case with learning AutoCAD—instruction should present opportunities to accommodate all learner profiles so that content can be absorbed and interpreted in a manner benefiting all students. Therefore, it should not be inferred that one format of instruction, such as experimentation and inference-making as suggested by John Carroll; or similarly, solving problems by deducing outcomes as suggested by John Sweller, would suit all learners. Rather, instruction should also account for those with a need to learn through concrete experience, reflection and observation, thinking though abstract concepts, or by active experimentation.

Kolb felt that understanding learner preferences was essential for developing curriculum that fostered a more robust process for acquiring knowledge, and provided students with adaptive skills for responding to new situations. The ultimate aim, said Kolb, was to

> ...make the student self-renewing and self-directed; to focus on integrative development where the person is highly developed in each of the four learning modes: active, reflective, abstract, and concrete. Here the student is taught to experience the tension and conflict among these orientations, for it is from the resolution of these tensions that creativity springs. (Kolb 1984, p. 203).

Each of the epistemological theories reviewed, from Carroll, to Sweller, to Kolb—presented unique and valuable perspectives regarding the acquisition of knowledge, particularly when viewed in the

context of teaching interior design students how to use AutoCAD. Despite their uniqueness, there was a common and pervasive thread that linked each of their theories—and that was Jerome Bruner's notion of constructing knowledge. Sweller used the term 'schema', and 'automation' to indicate that higher order concepts cannot be understood until lower order concepts have been categorized and organized into simpler constructs. John Carroll stated that computer instruction must be sequenced in such a way as to help learners master simpler component skills before carrying on to more complex tasks. (Carroll, 1991, p.71). David Kolb described the entire experiential learning process as one which used previous adaptive strategies to inform subsequent ones. Bruner himself described this process of constructing knowledge as central to learning, and elaborated by saying,

> We easily become overwhelmed by complexity or clutter. Cognitive mastery in a world that generates stimuli far faster than we can sort them depends upon strategies for reducing the complexity and the clutter. (Bruner, 1971, p.4)

Although each of these theories expounded the virtues of constructing knowledge, they rarely addressed the design of the communication devices that made evident the instruction. John Sweller did acknowledge visual design, to some extent, with his studies that examined split-attention effect. By demonstrating that diagrams integrating text and image fostered learning more quickly and effectively than those that did not, he concluded that instructional material should be formatted with less concern for aesthetic, and more concern for physical integration of disparate pieces of information. He felt that aesthetics and function were mutually exclusive, and added, "...it is rare for integrated materials to have the aesthetic appeal of a conventional, split-source format." (Sweller 1999, p.133). Carroll also addressed visual communication design for computer manuals by suggesting that text should be kept to a minimum, information should be modularized, and the size of the manual kept small to prevent new learners from being intimidated. (Carroll 1999, p.43).

These educational theorists recognized that curriculum should contain only content that is necessary, be ordered hierarchically, presented simply, and accommodate various learning profiles. Given these instructional principles, it would follow that the design of the visual communication fulfil these objectives also. This is of particular importance in the complex domain of computer instruction, where learning is facilitated primarily through visual materials such as

user-guides and computer manuals. Sadly, these theorists viewed visual communication design as a mere postscript to fostering learning, as opposed to a mutual partner in affecting the cognitive process of learners. But as Jorge Frascara stated in *User-centred graphic design*,

> The objective of all visual communication is to effect a change in the public's knowledge, attitudes, and behaviour. For such a change to happen, the communication must be detectable, discriminable, attractive, understandable, and convincing. (Frascara 1997, p. 3).

Analogous to experiential learning theory, visual communication design plays a shared and vital role in influencing perception, absorption, analysis and experimentation. This is most evident in the field of information design. The primary purpose of this domain of visual communication is to inform and educate—whether directing people through an air terminal, demonstrating how to fill out a tax form, or explaining how to rectify a paper jam in a photocopier—the visual arrangement of text, images, and graphic elements serves to enhance human functioning.

Visual Communication Design

How are successful visual communications achieved, and how is their success measured? Information designer Paul Mijksenaar addressed these questions in his book, *Visual function, an introduction to information design*. By compiling a number of graphic examples —both successful and unsuccessful— Mijksenaar demonstrated what constitutes a well-composed visual message. These examples ranged from building signage to automobile dashboards; subway maps to evacuation instructions—essentially those visual messages which were intended to affect the thoughts, feelings, attitudes, and actions of human beings.

By examining various treatises on good design, including those by renowned architects Louis Sullivan, Walter Gropius, and Henry van de Velde, Mijksenaar proposed an evaluation system for judging the efficacy of a visual message. He borrowed the treatise of Vitruvius, the first century Roman architect, who defined successful architecture as possessing *firmitas, utilitas, venustas*—or *firmness, utility, beauty*. Mijksenaar contended that each of these elements are inextricably tied, and essential for creating meaningful and memorable visual messages. (Mijksenaar 1997, p. 18). The degree to which one element is expressed over the other is dependent upon the context and purpose of the message, and to whom it is addressed. Yet the underlying goal is to achieve an optimal balance of all three elements, so that readers are

attracted to the message (it elicits satisfaction); the message is easy to read and comprehend (it demonstrates utility); and provides relevant and necessary information (it proves reliable).

Based on the Jacques Bertin's theory of 'graphical variables' Mijksenaar also clarified the visual elements that comprise a graphic message—what they are, and the variables involved in manipulating them to achieve effective communications. These elements include typeface, colour, images, and layout. Their arrangement thus serves to differentiate, categorize, and accentuate varying levels and types of information. For instance, he asserted that by altering form and colour, one could distinguish categories of information. By working with size and density, one could differentiate hierarchical relationships, and by utilizing lines, symbols and logos, one could emphasize specific features. Ultimately, stated Mijksenaar, information was shaped by:

- emphasizing or understating
- comparing or ordering
- grouping or sorting
- selecting or omitting
- opting for immediate or delayed recognition
- presenting it in an entertaining fashion

(Mijksenaar 1997, p. 25)

In other words, graphic architecture determines where and how fast the eye moves to perceive information, how one links information and makes connections, and how one compares, contrasts and relates concepts. The layout and ordering of content, character and quality of images, selection of typeface character and size, use of graphic elements such as lines, arrows or symbols, choice of colours, influences how a reader perceives, interprets, and comprehends information. There exists a reciprocal relationship between cognitive functioning and visual design.

In his book, *The visible word*, graphic designer Herbert Spencer compiled many empirical studies to help clarify this relationship. These studies, conducted during the first half of the twentieth century, elucidated the specific elements of typography which enable perception, legibility and readability. They confirmed such factors as reading rates of adults; the physiological movement of the eye as it reads; letterforms that are most legible and most readable; and type sizes and line lengths that are most conducive to efficient reading. Spencer provided evidence that reading was not accomplished by discerning individual letters that comprise a word, but rather by recognizing a word's overall shape. This

shape is determined by the consistent combination and configuration of the various letters that comprise the word. Much like schema recall, efficient reading occurs when words are recognized by their visual pattern, and not by analyzing their constituent parts. A letter's form, size, and proximate relationship to other letters, influences how quickly and easily word shapes are recognized. Spencer cited studies showing that words are recognized more easily when lowercase letterforms are used, since ascenders and descenders contribute to a more varied word shape. When all capital letters are used, words appear too consistent in profile, and therefore difficult to distinguish.

Studies demonstrated that the optimal letter size for reading a body of text is between 9 and 12 points. Yet this differs for children and the elderly, who generally require larger type to help differentiate word shapes. Typesize, in turn, is influenced by reading distance. If reading distance expands outside of its normal range of twelve to fourteen inches, type sizes appears smaller. For instance, "...a 12 point type read at 18 inches is the equivalent of a 10 point type at 15 inches". (Spencer 1968, p. 35).

Readability is also affected by the number of characters comprising a line of text, and the amount of spacing between lines of text. If a line of text is too long, the pace of reading is diminished because readers tend to lose their way. If a line is too short, readers become distracted by the abrupt and frequent line changes and comprehension is ultimately hindered. Studies determined that the optimal length of line consists of 12 to 15 words—or between 60 and 70 characters, including spaces and punctuation. For shorter spans of text though, a line length of 40 characters is considered acceptable. (Spencer 1968, p. 35).

These statistics were reiterated by James Craig, in his book, *Designing with type*. With respect to typesize and readability, Craig noted that,

> How we read, and therefore how we design, involves subtle and complex factors based on our eyesight and conditioning. Most of the type we consider comfortable reading is clearly seen at arm's length. Given normal eyesight, this distance will dictate a preferred text type size and linelength, usually 9–, 10–, 11–, or 12 point type and 35 to 70 characters on a line. (Craig 1999, p. 28).

Craig also stated that typeface character was equally important to readability and that it should be both legible and appropriate. In other words, letterforms must be easily distinguished and adequately convey

the mood of the content. As typographer Robert Bringhurst suggested, "Letterforms have tone, timbre, character, just as words and sentences do." (Bringhurst 1999, p. 22). Some terms Bringhurst used to describe various typefaces included 'subtle', 'dynamic', 'elegant', 'squat', 'rigid', 'fluid', 'regal', and 'imperious'. Bringhurst rationalized a typeface's character based on the various features that constitute the letter's form such as overall proportion, stroke weight, axis, inclusion of serifs, shapes of terminals, and size of aperture (openings in letters such as e, a, b, and d). In describing type, Bringhurst often labelled it in terms of its visual impression, as well as its specific features. Gill Sans, for instance, was described by Bringhurst as, "...distinctly British but highly readable sans serif, composed of latently humanist and overtly geometric form. The aperture varies." (Bringhurst 1999, p. 242). Concerning a typeface selection, Bringhurst, Craig and Spencer agree that the typeface's inherent character must align with the mood and spirit of the text.

Bringhurst contended that layout of text also plays an important role in the discrimination and interpretation of information. Therefore, in terms of graphic design layouts, if a recognizable pattern of information emerges, the underlying message will be more evident. This was reiterated by Frascara, who stated, "One of the main tasks of the visual communication designer is to facilitate the ordering process that perception and understanding involve. Perception is an intelligent act." (Frascara 1997, p. 29).

This description of how graphic information is discerned was comparable to psychologist Carol Bloomer's description of how humans perceive their environment. According to Bloomer, an expert on human perception, humans are attracted to elements that are emphasized, and interpret these as being the most prominent pieces of information. They then scan additional information to determine hierarchy and relativity. It is from this process of organization that humans interpret their visual environment. (Bloomer 1994, p. 18).

In terms of visual communication design, graphic designer Allen Hurlburt suggested that in order to present information in a manner that is conducive to human perception, it should be arranged coherently and consistently. He proposed that this is best facilitated through the use of layout grids. In his book, *The grid*, Hurlburt recommended that layouts should be governed by a basic grid structure of rows and columns to contain information and to provide logical, harmonious options for layout alternatives. (Hurlburt 1978, p. 18).

Weiss also provided suggestions for organizing information, particularly with respect to instructional manuals. He considered predictability and modularization of layouts to be beneficial, because it allows the reader to focus on content, rather than seeking pertinent information and interpreting a variety of hierarchical relationships. (Weiss 1991, p. 50).

Weiss pointed to the Hughes Aircraft Association manual designed by J.R. Tracey in 1960 as an example of a successful layout for modularized instruction. Tracey's design included a consistent pattern of layout whereby the thesis title and accompanying explanatory statement were always found on the upper region of the left page (verso), with charts, figures and diagrams on the right page (recto). Modules consisted of two facing pages, which provided a distinct and predictable start and end to the instruction. Weiss claimed that the success of this manual was due in part to a consistent layout—once readers grew accustomed to the rhythm of this layout, the instructional content became more visible. (Weiss 1991, p. 50).

Clearly, the visual composition of instructional content is equally important as curriculum design for helping learners to achieve their goals. Recognizing Sweller's notion of reducing cognitive load to maximize the capacity of working memory, one could reduce stress on the working memory if layouts are organized, predictable and cohesive; if typefaces are legible and easily recognized; and if the ordering of information works in conjunction with natural patterns for reading.

Usability testing

The only way to determine if instructional designs and visual communication designs have achieved their stated goals, is through usability testing. As Frascara stated, "If designers are to be concerned with the public's reaction to their communications, a system of evaluation must be included in the design process." (Frascara 1997, p. 5).

The traditional design process of problem definition, analysis, concept development, ideation, and deployment is very similar to Kolb's model of knowledge acquisition. By obtaining concrete facts and observing the various conditions of a problem, designers are able to recognize and analyze the problem condition. By interpreting these observations, designers are able to form concepts regarding potential solutions. By studying these concepts, designers are able to develop strategies for solving the problem, and by implementing these strategies, designers are able to deploy solutions for resolving the problem.

However, solution implementation marks only half of the design process. If a final solution is to be considered successful, the design

cycle of acknowledging, observing, analyzing and implementing must be revisited in order to test the initial solution and thus create a satisfying, functional and usable product. Jeffrey Rubin, author of *Handbook of usability testing: how to plan design and conduct effective tests*, called this process 'iterative design', and stated that,

> ...the optimum design is acquired through a process of trial and error, discovery and refinement. Assumptions about how to proceed remain assumptions and are not cast in concrete until evaluated with the end user. The end user's performance and preferences are the final arbiters of design decision. (Rubin 1994, p. 17).

At the centre of this process of designing, testing and refining however, were the users—who Rubin felt were paramount for providing both input and feedback regarding product development. If a product was deemed not usable by its intended audience, then it was regarded simply to have failed. (Weiss 1991, p. 34). Therefore, according to Rubin, the pre-eminent goal of usability testing is to create products that are, "easy to learn and use, satisfying to use, and provide utility and functionality that are highly valued by the target population." (Rubin 1994, p. 26). He also stated that design must be conducted from the 'human-out'. (Rubin 1994, p. 11). Consequently, with respect to user-centred design and usability testing, users' needs are considered central to both the preliminary design and testing process.

Although a specific method for research and evaluation has not been formalized in the domain of visual communication design, usability testing provides a useful model for determining the success of a designed product —particularly for instructional materials pertaining to computer usage. As Rubin clarified, usability testing has its roots in classical experimental methodology, but differs in that it is not intended to expand theories by testing a specific hypothesis using tight controls and randomly chosen participants. Rather, it is intended to improve products by using a representative sample of end-users who help test stated objectives. The product is often tested in a representation of the actual work environment, in a situation sensitive to both time and financial constraints, and with users providing both qualitative and quantitative feedback. (Rubin 1994, p. 29).

Frascara offered a specific example of this iterative, user-centred process, in the development of a traffic safety project. Essential to designing this communication was the identification of the problem that required action; analysis and definition of the scope and causes of the

problem; analysis and definition of the critical population affected by the problem; definition of objectives and strategies for reducing the problem; creation of a prototype design; testing of prototype with a sample target audience; refinement of the design prior to implementation to a wider audience; measurement of effects; and sustained continuation of the campaign with regular refinement. (Frascara 1997, p. 39).

This model of iterative design was similar to one proposed by Weiss, but differed slightly in that Weiss suggested testing a prototype early in the design process. That is, the design should not be too far along in the process such that it could not be easily revised. Rubin, on the other hand, declared there should be up to three testing phases which occur as the design becomes more detailed. The first test, was referred to as the 'exploratory test', and occurred during the preliminary design of the product. At this stage, users provide only a quick overview to test the skeletal features of the product. The second test, was called the 'assessment test' and was conducted after the product was 60-80% complete. The final test was deemed the 'validation test', and occurred when the product was fully functional. This schedule for testing differed from Cady's model, which suggested that once a design prototype was created, it should be continually tested and refined until it was ready to be released to a broader audience.

Critical to the testing process however, is the gathering of effective, relevant, and useful data, both before and after the design prototype has been completed. Zoe Strickler, a contributor to *User-centred graphic design*, suggested that a number of data collection methods which result in both quantitative and qualitative feedback should be used in order to provide a balanced and insightful measure of user preferences relative to product performance. Among these methods are participant observation, focus groups, interview, and survey questionnaires. This was restated by technical writers Kirsten Woolever and Helen Loeb in their book, *Writing for the computer industry,*

> By watching people use the documentation and by talking to them about it, you may gain perspectives not provided by other tests. However, this kind of test should be done in conjunction with one of the other types. Qualitative information alone is not sufficient to evaluate the usability of the document." (Woolever and Loeb, 1994, p. 173).

If conducted judiciously, usability testing should expose both weaknesses and strengths of the designed product. Rubin maintained

that successful user documents promote efficient learning and are both satisfying and easy to use. (Rubin 1994, p.26). Cady felt that successful documents were free of 'typographic errors, omissions and discrepancies'. (Cady 1996, p.8). Weiss stated that successful user documents for computer applications would respond to user needs; reduce the amount of skips and jumps a learner must take to find and connect information; be readable, clear and reliable; and allow for efficient modification and revision. On the other hand, Weiss also stated that a user document is said to have failed if, "the user/operator is unable to work because of it—if a mistake, malfunction, or interruption can be blamed directly on the manual." (Weiss, 1991, p.34).

Carroll pointed out that even if a document is free of typographical errors, omissions and discrepancies, it would not prevent a user from misreading or misinterpreting information. According to Carroll, research demonstrated that new learners spent up to 25 and 50% of their time recovering from errors. Ideally, a document must provide a means for error diagnosis and recovery. Carroll defined error types as *semantic, syntactic,* and *slips*. He observed that *semantic* errors occurred when users selected an incorrect option to carry out a task. *Syntactic* errors occurred when a specific sequence of commands were carried out in the wrong order. *Slips* occurred when users inadvertently hit a wrong key or icon. (Carroll 1998, p.34).

In order to detect error potentialities, Carroll insisted that usability testing, through observation of product use, is critical. Carroll described the benefits of usability testing for minimizing error states in the results of one of his studies:

> The presence of error information helped subjects detect 33 per cent faster during training and led to 28 per cent better diagnosis and 73 per cent more successful correction after training." (Carroll 1998, p.35).

Rubin stated, "It is easy for designers to lose touch with the fact that they are not designing products per se, but rather they are designing the relationship of product and human." (Rubin 1994, p.9). It appears therefore, that in order to design effective, meaningful tools for learning a complex computer application such as AutoCAD, both the design of the curriculum and the manner in which it is communicated relative to the specific needs of the learners must be acknowledged. Not only must their unique learning profiles be addressed, but also their unique demographic circumstances in terms of previous education and experience, personal preferences and value systems. This can only be

determined by a thorough analysis of the user, and a reiterative testing process that allows the user to shape the product. To this end, users are central in creating usable, satisfying, and functional products.

DESIGN OBJECTIVES

The intent of the preceding analysis—which included a closer inspection of the target audience, the nature of the AutoCAD software, the existing curriculum and a review of relevant literature—was to derive a solid understanding of the needs and issues surrounding the design of instructional materials for AutoCAD specific to both instructors and students of interior design at Mount Royal College. These issues are summarized as follows:

- AutoCAD is a cognitively complex computer drafting application which falls into the convergent learning domain—a subject that involves problem-solving by transforming abstract, theoretical concepts.
- Former learners and instructors in the AutoCAD course found that the existing curriculum and instructional materials did not facilitate competent skill-building in AutoCAD.
- Some learners, who preferred to learn through experimentation, felt that the course content was delivered too slowly. Those who required detailed instruction, felt that the content was too overwhelming.
- Without time to practice and integrate their knowledge, students felt that the amount of content conveyed was too great given the available time.
- Although various types of learning opportunities were provided (demonstration, practice exercises and independent practice), learners were reliant upon the instructor for setting the pace of the curriculum and resolving technical errors.
- According to the instructors, students were too dependent upon the teacher for resolving problems, thereby diminishing students' ability to problem solve effectively through successful recognition of, and recovery from, errors.
- Instructors wanted a curriculum and instructional materials that were specific to interior design drafting curriculum at Mount Royal College.

Based on these issues, and a review of appropriate literature, the following objectives for creating successful instructional materials that

satisfied the needs of the target audience were determined. These are as follows:

- Student confidence and learning success must be facilitated by creating learning opportunities that are responsive to the four defined learner profiles (Kolb).
- The curriculum should teach only those concepts essential to architectural drafting, be sequenced logically, and facilitate student productivity by having them engage in simple, relevant tasks early on. (Carroll).
- Cognitive load should be minimized by providing guided exercises or worked examples that enable students to develop appropriate schema and automation for enhancing problem-solving capabilities. (Sweller).
- Instructional materials should provide a means for all learning profiles to recognize, diagnose and rectify errors, yet at the same time, create situations that encourage independent resolution of problems. (Carroll).
- In terms of their visual design, instructional materials should clarify the curriculum by being congruent with the instructional objectives and the needs of the intended users. (Frascara, Rubin, Weiss, and Cady).
- The visual elements must be selected and arranged in a way that helps the reader to distinguish, categorize, and interpret the various items of information. (Mijksenaar, Hurlburt, and Weiss).
- Typeface character, size, line lengths, and line spacing must be appropriate and conducive to reading and comprehension of information. (Bringhurst, Spencer, and Craig).
- The form of the visual design must align with the content of the instruction, as well as appeal to the intended users. (Frascara, Mijksenaar, Bringhurst, Spencer, and Craig).
- A series of iterative tests are required to arrive at a satisfying, functional, and usable product. (Frascara, Rubin, Weiss, and Cady).
- These tests should involve an exploratory assessment of a skeletal design prior to the production of a prototype, a more thorough exploratory test involving a prototype developed to 80% completion, and a validation test of the prototype refined by data acquired in the exploratory test. (Weiss).
- Exploratory and validation tests should involve observation of students using the prototype in an actual teaching situation as well as focus groups and survey questionnaires. These tests should

provide both quantitative and qualitative data to determine user satisfaction regarding the instructional content and form. (Strickler, Woolever, and Loeb).

- Data collection should be carefully sequenced during the sixteen week AutoCAD course, taking into consideration both students' time constraints and the deadline for creating the validation prototype. (Cady and Rubin).

These objectives served as the basis upon which all decisions concerning curriculum development and visual communication design for the course materials were made. A model providing a summary of these objectives and their accompanying strategies is presented on the following page. Based on this model, a description of how the design of the instruction and the visual format of the project unfolded is provided in the subsequent section.

instructional design strategies	objectives	visual design strategies
• *include only content relevant to drawing practices of interior design* • *ensure curriculum provides appropriate level of challenge*	**consider needs and demographics of target audience** (Frascara, Rubin, Weiss)	• *align visual character with the profile of interior design students* • *ensure materials are readable, portable and affordable*
• *provide essential facts (CE)* • *promote queries, ask questions (RO)* • *include guided exercises (AC)* • *include independent lessons (AE)*	**acknowledge various learning styles** (Kolb):	• *include diagrams to support text (CE)* • *create space for note-taking (RO)* • *develop a linear format for exercises (AC)* • *include diagrams to be drafted (AE)*
• *minimize verbiage* • *reduce redundancy* • *include only essential topics*	**minimize cognitive load** (Sweller)	• *avoid superfluous detail* • *ensure clarity of text and images* • *provide integrated diagrams* • *ensure layout is predictable*
• *minimize reading and passive learning* • *ensure learners use AutoCAD skills immediately*	**allow learners to become task-oriented within a short time frame.** (Carroll)	• *use graphics which are simple and quick to draft*
• *sequence instruction from basic skills to more advanced skills* • *group together related topics* • *use worked examples (guided exercises)*	**structure the learning sequence to allow for logical schema development** (Sweller)	• *ensure diagrams increase in detail* • *ensure information hierarchy is clear and simple to interpret* • *ensure start and finish of lessons is evident*
• *provide practice exercises that translate actions undertaken* • *include information regarding error potentialities*	**support error diagnosis and resolution** (Carroll)	• *provide visual cues to demonstrate a correct path of progress*

DESIGN DEVELOPMENT

Given that the AutoCAD course was to commence in January 2002, the initial prototype had to be completed within a four-month time frame in order to be ready for usability testing. This allowed two months for research, analysis, and design development, and two months for production of the prototype. The prototype was to be developed to a level of 70% completion, then tested and evaluated over a one-month period. The remaining 30% of the instructional materials would be refined based on test findings, and evaluated during the final six weeks of the class.

Prototype Development

The design of the curriculum and the visual format of the instructional materials were simultaneous, yet distinct activities.

These activities commenced by determining the AutoCAD functions that would be included in the course. These functions served as topics, which were then organized into modules, or lessons of instruction. Based on the analysis of the software, these functions included only those that were 'essential' to know for architectural drafting, and only those that pertained to two-dimensional drawing. Lessons consisted of those functions that formed natural partnerships, such as *trim* and *extend*, and supported students in becoming productive quickly. For instance, the first lesson consisted of the commands *line, erase,* and *object snap*—the most fundamental commands for drawing simple, measured objects. Later lessons included commands such as *move, copy,* and *rotate,* which built on earlier lessons, and provided students with additional tools for drawing efficiently. By structuring information in this way, students would learn enough of the basics to make them productive in the first lesson, and develop an awareness of potential tools that would serve them later on.

The topics of instruction within each lesson centred around a single AutoCAD command function. The manner in which these commands were presented mimicked the instructional format used by the instructors in the AutoCAD course. This format consisted of a brief demonstration of how a command worked, followed by a practice

session using that command. The demonstration consisted of naming the command; explaining how and why the command was used; clarifying the various methods for initiating the command; and describing the series of steps involved in completing the command function.

The practice session consisted of a brief explanation regarding the objective of the exercise, and simple instructions for preparing the drawing file for the ensuing exercise. Students were then led through the necessary steps for achieving the end result. These exercises consisted of small drawing samples that were simple, concise, and easy to perform, and were intended to provide students with an opportunity to explore the various idiosyncrasies of the command being addressed. Each step within a practice exercise consisted of four events:

1. An explicit statement requiring students to do something, such as 'hit the erase icon'.
2. A checkpoint that allowed students to verify that their screen matched the instruction, such as 'you should see this'.
3. A checkpoint that allowed the student to verify their command line matched the instruction, such as 'your command line should read this'.
4. A debriefing statement that clarified the operation or the command line query, such as, 'AutoCAD wants to know which element is to be erased'.

This format was maintained in the instructional design, as it appeared that learners gained practical experience quickly, recognized and diagnosed errors easily, and interpreted AutoCAD's complex language effectively. This teaching structure also paralleled Carroll's principles of minimalism, which suggested that instruction should allow the learner to become productive immediately, and it should support error diagnosis and recovery.

This instructional design template was translated into a format which consisted of command demonstration, accompanied by a guided exercise, and culminating in an independent assignment. Lessons were designed to be completed within a four-hour lab period. They began with a brief introduction describing what was to be accomplished, and ended with a drawing assignment incorporating all of the topics covered, as well as topics covered in previous lessons. In this way, lessons were sequenced to build on previous knowledge, allowing students to hone their skills as the lessons grew in complexity. Essential commands were taught first, and commands that were important, but less frequently used, were taught later. Consideration was also given

to teaching the more complex commands later in the course, when students developed a more sophisticated understanding of the AutoCAD vocabulary. For instance, the *arc* command, was presented in the fourth lesson, when students would have more experience with AutoCAD's language of geometry and Cartesian coordinates.

Some commands were purposely disregarded, since they were not essential for beginning drafting. The curriculum was therefore minimized to include only those commands which were necessary for creating architectural drawings. Drawing templates, containing pre-formatted drawing styles and layout sheets, were created for the students. These were prepared so that students could concentrate on drafting, rather than the complicated task of formatting their drawings—a job normally assigned to senior CAD operators, and one which would cause needless stress to new learners.

Each lesson culminated in an assignment designed to accomplish three things: to incorporate all the information presented in that lesson; to practice skills from the previous lesson; and to give students an awareness of drawing standards as they pertained to the architectural profession. Assignments consisted of drawing interior design elements such as furniture, partition plans and architectural casework. In some cases, quick assignments were threaded within the lesson ('warming up') as a means of reviewing the previous module, and to prepare for the ensuing lesson. As students became more skilful and efficient in their use of AutoCAD, the complexity of assignments increased. By the end of the seventh and final lesson, students were required to draft and plot a complete set of architectural plans they had drawn manually in a previous course. This assignment consisted of up to eight pages of drawing details which were to be dimensioned, labelled and referenced according to architectural drawing conventions.

Visual Design

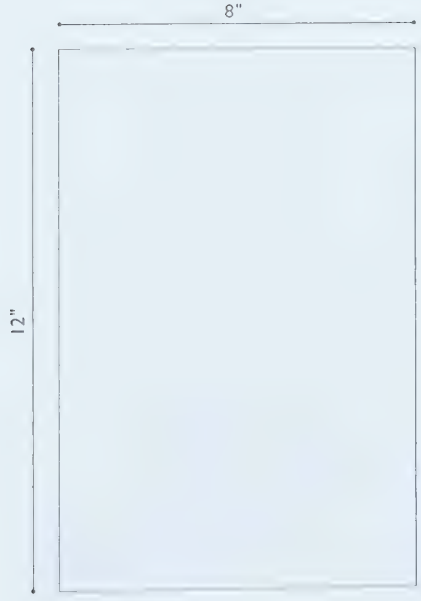
The visual design began to take shape along with the development of the curriculum. It was decided early in the prototype design phase that printed media would be the most suitable format. This was because students required maximum screen space to complete the guided exercises, and if digitally presented, the instruction would have compromised the workable screen area. Moreover, digital media would have required reliable computer technology to retrieve its contents. By adopting a print format, students would then be equipped with an

accessible medium which would allow them to read, absorb, analyze, and interpret the contents at any time or location.

The book was referred to as an AutoCAD *workbook*, instead of an AutoCAD *manual*, because manuals tend to provide only instructions pertaining to specific elements of operation, as opposed to a sequenced curriculum for learning. As a result, manuals have a tendency to induce passive learning by simply requiring readers to follow directions, rather than encouraging them to reflect, question and experiment with the various features of the computer application. By contrast, the workbook was intended to encourage students to interact within the instructional space by providing them with a place to make notes, facilitating experimentation, encouraging reflection, and learning through practice and problem-solving.

Layout (Appendix A, p. 94)

A format which emphasized verticality was preferred to accomodate the sequential nature of the guided exercises. The size of this format, fitting within a standard paper size, needed to be long enough to maximize the number of steps within a guided exercise on one page, yet narrow enough to fit on a computer lab desk when opened. Although it was not explicitly stated in the analysis of the instructional materials, it was felt that the workbook should be distinguished in proportion from other textbooks, yet still be easily carried and stored. For this reason, a page proportion of 8 x 12" was established. This fell within legal size paper dimensions and permitted graphic bleeds if necessary. It provided enough space to include all information pertaining to a command on a single page, as well as room for a maximum of six steps in a guided exercise. It sat comfortably on a computer lab desk and fit inside a standard student backpack. The 2:3 proportion was geometrically logical, and elicited a clean, elegant appearance. These characteristics were in keeping with the desired visual character for the workbook, which was to acknowledge the interior design students' design sensitivity, and the mathematical character of the AutoCAD application.

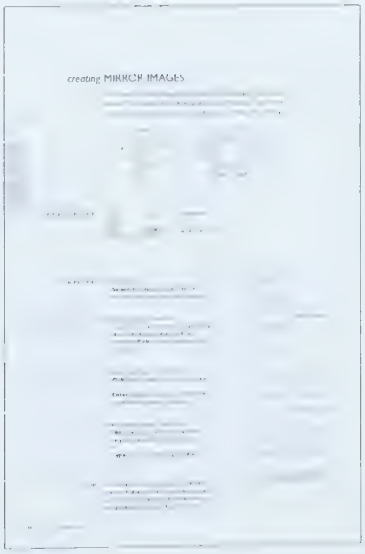


Within this 8 x 12" layout, a grid was required to facilitate a flexible system for incorporating a series of images and text. Due to the large number of screen captures, which fell within a 3w/2h ratio, a grid structure of 8 columns and 8 rows was created. This provided a harmonious, yet flexible layout that easily accommodated the different proportions of textual and graphic information, particularly the guided exercises that contained four distinct pieces of information: an instruction, a screen capture, command prompt information, and explanatory

information. Moreover, the 8 rows were congruent with the number of modules in the overall book. Margins were set at 36 points for the top, bottom and outside margins, and 54 points for the inside margin. Again, this was to maximize page use, but still provide reasonable space to hold the book or to make notes, while considering binding needs. (Appendix A, p.94).

With regard to individual page layout, the demonstration page —which included the thesis statement and information pertaining to command operations—was positioned on the left side of the layout on a single page. The accompanying guided exercises appear directly opposite on the right page. Therefore, by always beginning a topic on the verso, learners would know when a new topic began, and when one is completed. Learners would become accustomed to looking in distinct regions of the workbook to find specific pieces of information. Therefore, rather than encumbering the cognitive load by trying to locate information, learners would focus their attention on the content. (Appendix A, p.98).

The demonstration of a command was separated into four components. These were the introduction of the command; methods of how the command could be initiated; the steps involved in carrying out the command; and tips for efficient drawing. The command heading introduced the command and focussed on what the command was used for, rather than the given name of the command. For instance, instead of using the command name *Block*, the heading read, *Creating a drawing library*. Headings formatted in this fashion clarified the inherent purpose of the command, rather than forcing learners to decipher the AutoCAD nomenclature. Command introductions appeared between the second and third rows of the grid, allowing ample white space to emphasize this section and include images pertaining to the 'before and after' conditions of the command. The introductory text spanned five columns, allowing a readable line of approximately 66 characters of 10 point type.

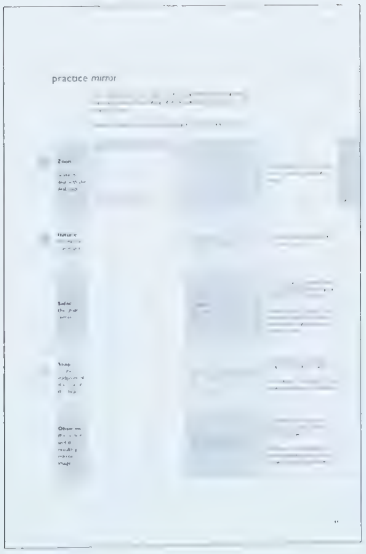

creating MIRROR IMAGES

The second portion of the demonstration page was dedicated to the command initiation, or 'prompt' methods. These methods typically involved one of either four approaches—hitting an icon, typing in the command name, highlighting a series of menu labels, or using quick keys. In order to keep this information direct and obvious, a simple table format showed the command prompt method above the graphic representation of the actual icons, menu labels, command names and quick keys. This information fell into the fourth row of the layout grid.

The third area on the demonstration page was devoted to showing the various steps and subsequent input required to complete a command. This information was contained between the fifth and seventh rows of the layout grid. Each command contained its own unique set of prompts that demanded a certain type of input—either using the mouse and cursor, by typing a specification, or by conversing with a dialogue box. Each step needed to be clear, as did the "input" and "follow-through" for each step. This distinction was rendered visible by indenting the input of the command information directly below its corresponding command sub-prompt. The white space after each step provided a means to distinguish the series of steps involved in a command sequence. When information was specified in a dialogue box, the dialogue box appears in this area along with labels indicating the required input.

Images, clarifying the textual information, were laid out to align with each step of the sub-prompt to which they pertained. The textual information explaining command sub-prompts occupied two columns, and the accompanying graphics occupied one column. This provided an effective balance of maintaining a readable line of text (40 characters) while preserving graphic clarity.

The final area of the demonstration page was devoted to drafting tips, which included either a brief description of how to accomplish something with more efficiency, or a brief explanation regarding the idiosyncrasies of that command. This information appeared in the final row of the eight-row grid and, being consistent with the information directly above it, spanned two columns.



Guided exercises, located on the right and subsequent pages, also contained distinct pieces of information. These included a heading, a brief description of the intent of the exercise, a graphic image depicting the completed version of the exercise, and the subsequent steps involved in achieving the result. The first two rows of the layout grid were dedicated to the introductory information, followed by five rows, or steps of the guided exercises. The final row was left empty to provide a sense of pause and relief, and to make the series of exercises appear less overwhelming. Subsequent pages of guided exercises were contained between the second and seventh rows of the grid, balancing the need to maximize the number of steps, and allowing room for students to make notes.

The activities within each step of the guided exercise were broken down as follows:

- an instruction to do something
- a visual cue showing the effects of the instruction
- the subsequent command prompt as a result of the instruction
- an explanation of what this command prompt meant

Because of the nature of these varying types of information, the guided exercises were organized horizontally within a derivative of the five column grid. The instruction component, being concise and direct, was contained within half a column width. The visual cue, which involved a screen capture for learners' to check their progress, fell within a typical column width. The command prompt information and the subsequent explanation occupied the next two columns. The entire guided exercise was aligned 54 points from the inside margin, permitting space for visual reminders of the icons needed to initiate a command. (Appendix A, p. 99).

At the end of a guided exercise, wherever possible, a space was left to purposely allow for pause. In some cases, this pause was used to provide summary information, (**d**|brief); a clear space for note-making; or a means to shift the beginning of the next topic so that it consistently fell on the left facing page. (Appendix A, p. 101).

The end of each module is signalled by the lesson assignment (**a**|ssignment). This exercise is organized much the same way as the demonstration page, and includes a brief description of the objectives of the assignment, the requirements of the assignment, and tips for completing it efficiently. The right facing and subsequent pages are devoted to the images to be drafted for the assignment. (Appendix A, p. 102, 103).

Typography (Appendix A, p. 104, 105)

Overall, the layout was structured to provide a balance between predictability and novelty; maintain legibility and readability, yet contribute to a clean, minimal, architectural appearance, so that the functions of AutoCAD appeared concise and simple to follow. The typeface character and size were also kept visually simple. *Gill Sans* was chosen as the primary typeface, and used for both headings and text. It is clear and easy to read because of its clean geometry. It also proved to be readable between 8 and 12 points, and offered both consistency and diversity when used in its different weights and structures: regular, italic, bold, and italic bold. Typeface sizes were as follows: 18 point for topic headings, 10 point for normal text, and 8 point for margin notes and diagram labels. All bodies of information were

set with 2 points of leading, except the introductory text, which was set with 6 points of leading. Important action words, either in the title heading or input required in a command sequence, were differentiated from the body text either by being set in italics, or in bold. Diagram labels, provided additional information or 'asides', and were distinguished in their hierarchy by being set in italics and reduced to 8 points. In the event where information was considered 'helpful', not 'essential', text was rendered in a grey value of 70%.

The typeface *Courier* was utilized to maintain consistency with the command prompt typeface used in the AutoCAD interface. Since command prompts are generally difficult to decipher for first time readers, it was determined that this prompt would be recognized and interpreted more easily in the workbook if it remained true to its original form. The other typeface used was *Tekton*. This appeared where architectural images required dimensioning, since this typeface is legible in compressed spaces, and its character resembles architectural script used in AutoCAD drafting.

Graphic elements

To ensure a clean, simple, appearance, graphic elements such as lines and shaded boxes were kept to a minimum. Where used, they served as functional devices to accentuate or differentiate various pieces of information. This was particularly useful in the guided exercises where varying values of grey were used to distinguish between the activities in each step, and between the steps themselves. A hairline below each step contributed to the clarity of this differentiation. Additionally, hairlines were used to distinguish the headings for *Command Prompt*, *Command Sub-prompts* and *Tips* on the demonstration page. These horizontal lines also served as a visual counterpoint to the vertical nature of the columns of text and images.

Images

Images and screen captures were very important features for the workbook. First, they encapsulated textual information very efficiently and effectively. Second, they provided a means to verify information produced on the screen in guided exercises. Third, they contributed to the architectural appearance of the workbook. Images fell into three different categories: those that depicted the results of a specific function; those that captured a sequence of commands in a guided exercise; and those that served as assignment diagrams. To ensure ease of interpretation, all images are kept simple in form, using only images familiar to the

interior design profession. In keeping with the concept of minimalism, and to avoid cognitive overload, images were kept spare in their overall shape, detail, and line weight. This was particularly important in the screen captures for the guided exercise, since their size did not afford a large amount of detail. In larger architectural drawings, line weights were varied to emphasize hierarchical relationships—in other words, features which were closer in the field of vision were heavier, those further back or less distinct, were lighter.

The interior of the workbook was printed in one colour, with tonal contrast provided by varying grey values. This was in the interest of keeping the workbook affordable to students. Colour was used only on the cover, to provide variety and interest to the workbook. The colour palette consisted of a monochromatic scheme of blues. These blues were consistent with two themes: the visual character of architectural blueprints, and the identity system of the AutoCAD 2002 interface. The cover also included an area for the student to identify the book as his or her own. This was styled after a standard architectural drawing label, and served to accentuate the concept of 'workbook'. (Appendix A, p. 95).

Navigation (Appendix A, p. 106)

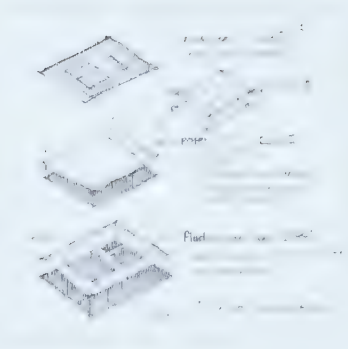
The navigational devices included in the first prototype consisted of a table of contents, running footers on the left page that identified the page number, lesson number and lesson name. The right page provided only the page number. An additional navigational device was a grey shaded box (36 points wide x 108 points long) on the outside margin of each page. This box listed the topics included in that lesson, and was located in the grid region pertaining to the lesson number. For instance, in the first lesson, this box fell into the first row of the grid. It moved downward to the second row for the second lesson, and so on. As the reader progressed through a lesson, the names of the topics changed from black to white, white identifying which topic was being covered. This feature was intended to bleed off the edge of the page to provide readers a sense of where each lesson fell without having to open the book. This device gave the reader an indication of the lesson on which they were currently working, the topics covered in that lesson, and the topics remaining.

The table of contents was structured to reflect the eight modules of the workbook graphically, and align with the navigational tabs. Lesson numbers were emphasized through their size and position. These numbers were positioned above the lesson title, which summed up the

concept of the lesson in two words. Each topic was listed in the section pertaining to the lesson number. The page number was justified to the left of the topic name to permit ease of reading. Once again, clarity and simplicity drove the concept for typography and layout. Although an index was intended for the final release of the product, it was not included with the prototype, since not all information pertaining to contents was available.

Production

The workbook was created using *Adobe InDesign* software, due to its compatibility with *Adobe Photoshop* and *Adobe Illustrator*—programs which are widely used for image manipulation. When tested against other similar applications, *Adobe InDesign* provided the best resolution for screen captures—a critical consideration for this project. Images consisted of a variety of file types, depending upon their graphic content. Screen captures were imported as Tagged Interchange Format File (TIFF). AutoCAD drawings used in assignments and other graphics were either imported as Windows Metafiles (WMF), or placed into *Adobe Illustrator* where line weights were adjusted and subsequently exported to the workbook document. The product was printed on paper that balanced quality with cost, and bound using a coil binding. The binding increased the flexibility in handling the workbook, providing students with options to read it one side at a time, or by laying it face open on the computer workstation.



The workbook was created by designing a topic for instruction, along with guided exercises, and sketching out ideas for their visual layout prior to producing the contents on the computer. Therefore, both the curriculum and its visual expression were simultaneously sketched-out prior to being formalized. Guided exercises were rehearsed a number of times before they were 'photographed' as screen captures. After five lessons (consisting of 46 topics) were created, they were submitted to the AutoCAD instructors for proof-reading. Corrections were made, and the workbook contents were printed using an *IBM Docutech* output device over a one-week time frame. The cost of the workbook prototype, including the first five lessons, colour cover, and binding, totalled $12.85—well within an affordable range for students.

After a four-month period of research, design, and production, the initial workbook prototype was ready for testing on the first day of the AutoCAD course.

USABILITY TESTING

The ultimate goal of the workbook as a learning resource was to inspire confidence and competence in the use of AutoCAD, so that interior design students could create a set of architectural drawings after seven lessons of instruction. In order to evaluate the initial exploratory prototype, a usability test was conducted over the fifteen week period of the Interior Design AutoCAD course. The primary purpose of this test was to determine the workbook's success based on the principles of usability testing—those being that instructional materials must satisfy the needs of a target audience by being easy to learn, easy to read, and satisfying to use. In the spirit of Vitruvius's, '*firmitas, utilitas, venustas*', the AutoCAD workbook must be functional, useful, and inspire a sense of delight in its intended users.

The usability test was broken down into three sections. The first section sought to confirm user demographics and learner profiles, as well as to obtain students' first impressions regarding the visual design of the workbook.

The initial inventory thus confirmed:

- average age of learners
- gender
- previous education prior to entering the interior design program
- perceived level of computer expertise
- learning style profile
- anxiety level regarding AutoCAD course
- motivation for learning AutoCAD
- first impression of AutoCAD workbook

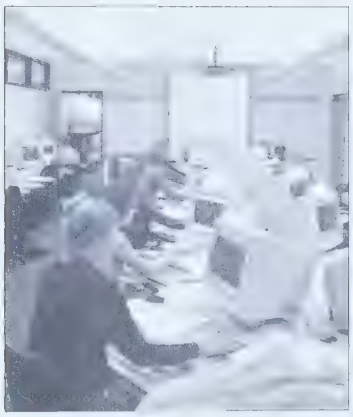
The second section of the usability test examined the workbook's visual design. This comprised the 'utility' aspect of the workbook, since it afforded access to the instruction. It tested the degree to which the information was readable and comprehensible, and if the visual qualities of the workbook aligned with the nature of the software, and the characteristics of the user profile.

The third and final component of the usability test examined how the various instructional features contributed to the students' comprehension of AutoCAD for the purposes of creating architectural

drawings. This component of the usability test comprised the 'functionality' aspect of the workbook, since the instructional design influenced the degree to which students became competent using AutoCAD. This portion of the usability test focussed on the adequacy of contents included in the workbook, the logic behind their sequencing, the pacing of the material, the degree to which the exercises and assignments were relevant for the users, and how well the curriculum served each of the four learning profiles.

Since user satisfaction, or sense of 'delight', was dependent upon the success of both the visual and instructional design, testing for this criterion was embedded in each component of the usability test. These tests measured user satisfaction with the visual character of the workbook, and the degree to which the curriculum inspired and motivated users to learn AutoCAD.

Instructional setting



The AutoCAD course consisted of two sections of students, with 20 and 16 students respectively. Each class consisted of a four-hour lab period, and took place once a week over a fifteen-week winter semester. Using the workbook sequence of lessons and assignments, the instructor calculated the delivery of the lessons based on the estimated time to complete assignments, and by accounting for missed classes due to academic breaks and holidays. The first five lessons of the workbook were covered in the first seven weeks of the course, and the remaining two lessons were covered over a period of five weeks. Lapses in lesson delivery were intentional to allow students additional time to work on assignments and to absorb the material. The workbook determined the content and sequencing of the course material, and the instructor influenced the pace of content delivery. Each lesson of the workbook was delivered in a single class period.

The workbook also influenced the manner in which a typical lesson was taught. The instructor introduced a new command by demonstrating its attributes and methods of operation. Students were then directed to complete the appropriate guided exercise as the instructor and lab assistant toured the classroom and aided students as required. This pattern of instruction continued for the first three hours of the class, with the final hour devoted to the summary assignment for the lesson.

Testing Methods

In order to gather meaningful and relevant information, various methods of data collection were used. These included recording observations during each AutoCAD class, administering survey questionnaires (containing both qualitative and quantitative-based questions), facilitating focus group discussions, and interviewing students and instructors on an informal basis.

Testing commenced on the first day of classes. Prior to instruction, the intent of the graduate thesis project was outlined, and the first survey questionnaire regarding user profile was administered to those students who had agreed to participate in the usability testing—which included 32 of the 36 students enrolled. This survey contained questions regarding age, gender, education, perceived computer expertise, level of motivation and anxiety for learning AutoCAD, as well as an abbreviated form of David Kolb's *Learning Style Inventory*. After the surveys were completed, each student received a workbook prototype. Students were then asked to record their first impressions regarding the visual character of the workbook. (Appendix C, p.118).

After three hours of the first class, when students were more acquainted with the nature of the visual and instructional design, they completed the second part of the questionnaire. This portion revisited the notion of user-motivation and level of anxiety to determine whether there had been a change in participants' attitudes after exposure to the workbook. The questionnaire also contained a request for research participation, whereby students were invited to volunteer either by participating in a focus group, and/or by completing additional surveys.

Using information taken from these questionnaires, two focus groups were established. These groups differed in terms of learning styles, degree of anxiety for learning AutoCAD, and level of computer experience. These groups were distinguished as follows:

students in ***group one***

- transformed information through active experimentation
- had little fear for learning AutoCAD
- were comfortable with computer technology
- were enthusiastic to learn AutoCAD

students in ***group two***

- processed information through reflective observation
- perceived AutoCAD as being difficult to learn
- had little computer experience
- were anxious about learning AutoCAD

The intent of this distinction was to determine if the workbook satisfied these two extremes of learners. In all, eight students were selected to participate in each of the two focus groups.

Classes were observed on an alternating basis—the first section was observed one week, the second section observed the following week. After students completed their third lesson, approximately three weeks into the course, they were asked to respond to the second questionnaire. This survey pertained to the visual design of the workbook and sought to establish the degree of success regarding its 'utility'. It considered proportion, layout scheme, typography, and navigational system. It also examined if students interpreted design elements as they were intended. (Appendix C, p.124).

Students completed this survey after the third lesson to allow enough time to evaluate, refine, and produce the final two lessons before they were to be introduced four weeks later. Twenty-nine of the 36 students enrolled in the AutoCAD course completed the surveys.

In addition to responding to these questionnaires, two focus group meetings were conducted to solicit feedback regarding the visual design of the workbook. These meetings were held after the surveys were administered. Six of the eight members of the first group met for over an hour, and five of the eight members of the second group met for twenty minutes. These meetings were conducted in an informal setting to provide a degree of comfort for the participants. Feedback was recorded through written notes, and students were assured that their commentary would remain confidential.

Based on the results of the questionnaires, the focus groups, and observations of the workbook in use in the classroom, the second prototype, consisting of lessons six and seven, was created. This prototype maintained the same format for instruction, but incorporated slight modifications to the visual structure. These modifications are discussed in further detail in the subsequent section.

After approximately twelve weeks into the semester, when the students had completed the seventh and final lesson, the last survey questionnaire was administered. This survey dealt with issues pertaining to the instructional design, or 'functionality', of the workbook. It examined if the workbook successfully conveyed the concepts necessary for learning AutoCAD, the students' level of trust that the workbook served as a useful learning device, if the different learning styles were satisfied with the pace and nature of the curriculum, and the potential for the workbook serving as a suitable device for independent learning.

Of the 36 surveys distributed, sixteen were completed and returned. Appendix C, p.137).

Throughout the course, both students and instructors provided feedback regarding the workbook. Prior to each lesson, the instructor tested the guided exercises and corresponding assignments. As typographical errors, omissions and discrepancies were discovered by both students and instructors, they were transcribed into the research prototype. Both students and instructors willingly and spontaneously offered feedback regarding the strengths and weakness of the workbook's visual and instructional design.

TESTING RESULTS

Due to time constraints and obligations arising from other courses, members of the focus groups were unable to meet after the first session. As a result, most of the data concerning the usability of the workbook was derived from survey information, personal observations during the class session, and informal discussions with students and instructors.

Learner Profile Results (Appendix D, p. 151–157)

Demographics

Thirty-two of the 36 students responded to the first questionnaire pertaining to learner profiles. The average of age of the student population was 23 years, and 87% of the learners were female. The following is a statistical account of the students' prior education and perceived computer proficiency:

prior education

high school diploma	22%
some post-secondary education	40%
post-secondary diploma	13%
university degree	25%

perceived computer proficiency

beginner	6%
advanced beginner	22%
intermediate	53%
advanced	19%
expert	0%

Learner attitude before the first class

Prior to their first lesson, and before having access to the workbook, students were asked to indicate their feelings toward learning AutoCAD. Students indicated their feelings by using a 5-point ranking system, with *very negative* ranked as 1 and *very positive* ranked as 5.
The following percentages indicate students' feeling about learning AutoCAD before completing their first class using the workbook:

1 *very negative*	0%	
2 *somewhat negative*	16%	
3 *neutral*	3%	
4 *somewhat positive*	34%	*attitude before class*
5 *very positive*	47%	overall rank: 4.12

Learner attitude after the first class

After the first class was finished, students were asked once more to indicate their feelings toward learning AutoCAD. Thirty-one per cent of the students changed their attitude about learning AutoCAD. Fifty per cent of these students felt more positive, and 50% felt less positive. The resulting change was insignificant however, since learner attitude ranked slightly above 4.0 both before and after the first AutoCAD class.

The following percentages indicate students' responses with respect to learning AutoCAD after completing their first class:

1 *very negative*	0%	
2 *somewhat negative*	3%	
3 *neutral*	19%	
4 *somewhat positive*	38%	*attitude after class*
5 *very positive*	40%	overall rank: 4.15

Some of the reasons students provided for feeling motivated about taking the AutoCAD course included being excited about learning something new, acquiring a skill necessary for employment, the chance to work with computers, and learning AutoCAD was a welcome change from manual drafting because of its precision and expediency. A student who reported feeling *very positive* about learning AutoCAD stated,

> I know how important this is in the industry and everyone talks about it. I would feel privileged to know and have the ability to use AutoCAD; it's the next step in this program and I'm looking forward to it. I'm also a bit nervous because it's a new program and a very big program.

Others, who were less enthusiastic about AutoCAD, generally reported feelings of being intimidated and overwhelmed by AutoCAD, with a dislike for computers. As one student declared, "I've never really enjoyed computers. I get frustrated easily using the computer. If I don't have to use one, then I won't." Some of the students' level of motivation increased as a result of the workbook. At least three of the students provided commentary that the workbook eased their concern regarding the course. After changing their attitude from *negative* to *positive*, one

student remarked that, "I find it much easier to do, and feel quite relaxed because the book guides you along step by step."

Students' initial perceptions regarding the degree of difficulty for learning AutoCAD

Prior to the beginning of the first class, students were asked to indicate their perceptions regarding the level of difficulty for learning AutoCAD. Students ranked their perceptions by using a 5-point ranking system, with 1 indicating *very difficult*, and 5 indicating *very easy*. The following percentages demonstrate students' initial responses regarding AutoCAD's perceived level of difficulty:

1 *very difficult*	6%	
2 *difficult*	41%	
3 *neutral*	44%	
4 *easy*	6%	*initial perception*
5 *very easy*	3%	overall rank: 2.59

Students' later perceptions regarding the degree of difficulty for learning AutoCAD

After their first lesson was finished, students were asked once more to rank the degree of difficulty in learning AutoCAD. Thirty-one per cent of the students changed their attitude, with 100% of these students ranking it as being easier than they had expected. The following percentages indicate their later responses:

1 *very difficult*	0%	
2 *difficult*	22%	
3 *neutral*	55%	
4 *easy*	20%	*later perception*
5 *very easy*	3%	overall rank: 3.06

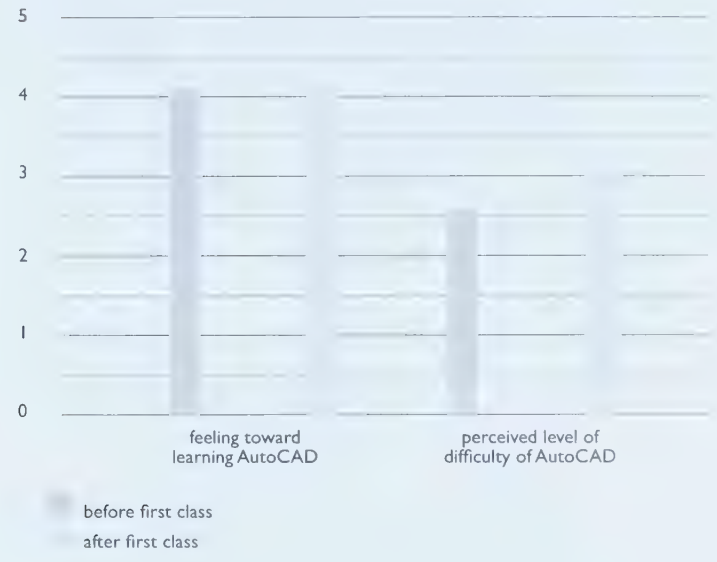
The change in perception regarding AutoCAD's level of difficulty was not significant, since AutoCAD was still ranked as being neither easy nor difficult, both prior to, and after the first lesson was completed.

Some of the students who felt less anxious about the complexity of AutoCAD reported that it was because they had either been previously exposed to AutoCAD, or that computer technology came easily to them. On the other hand, those who perceived the program to be difficult based their judgment on hearsay—that they had "heard of horror stories of major breakdowns." Others reported anxiety because

of their general fear of computer technology, or from a negative past experience with AutoCAD. As one student said,

> It took me a long time to learn AutoCAD in high school, as it did most of the girls in my class. The male students however, found it easier—as it was fairly self-taught.

LEARNER ATTITUDE + MOTIVATION



Learner Styles

Upon evaluation of the Learning Style Inventories, it appeared that there was a fairly even split amont students for their learning style preferences. However, in determining students' learning profiles, there were significantly less students who were convergent learners. The following percentages indicate the breakdown of students' learning style preferences and learning style profiles:

learning style preference

concrete experiences (CE)	23%
reflective observation (RO)	27%
abstract conceptualization (AC)	23%
active experimentation (AE)	27%

learning style profiles

divergent learners	30%
assimilating learners	27%
convergent learners	13%
accommodating learners	30%

Workbook impressions

Comments concerning first impressions of the workbook were generally favourable. Of the 26 students who responded, 100% provided positive comments, however 3 of the 26 students supplemented their positive comments with critical remarks. The favourable comments from students included that the workbook was well laid out; looked easy to follow and appeared less intimidating than other AutoCAD manuals; that it was detailed, comprehensive and thorough; that instructions were clear, and oriented towards interior design students; and that its size and coil binding made it easy to use. One student remarked, "It appears to be a successful cohesion of instructions geared especially towards us. I enjoy pictorials within instructions. . . ." With respect to its character, students described the workbook as being "cool", "dynamic", "professional", "straightforward", "authentic" and "design oriented". Criticism primarily focussed on the fragility of the workbook cover. Another student commented that the book appeared repetitive and was in need of a source for 'quick-reference' information.

Visual design (Appendix D, p. 158–173)

Three weeks after students had been exposed to the workbook, they were asked to provide feedback regarding the visual design of the workbook by means of a survey questionnaire. This survey was broken down into areas pertaining to the workbook's *structure, clarity, layout, navigation* and *miscellaneous features*. In addition to rating each of these components of the workbook's visual design, students were also asked to rank how important each of these features were to them. Ranking was based on a 5-point scale, with 1 indicating *not important at all*, and 5 indicating *very important*.

Structure: proportion, binding and durability (Appendix D, p. 158)

Students rated each aspect of the workbook's structure (proportion, binding and durability) on a scale of 1 to 5, with 1 being *poor* and 5 being *very good*. Their responses to each of these aspects of workbook structure are indicated by the following percentages:

8 x 12" proportion

1 *poor*	0%	
2 *fair*	7%	
3 *neutral*	0%	
4 *good*	48%	*proportion* overall rank: 4.30
5 *very good*	45%	level of importance: 4.07

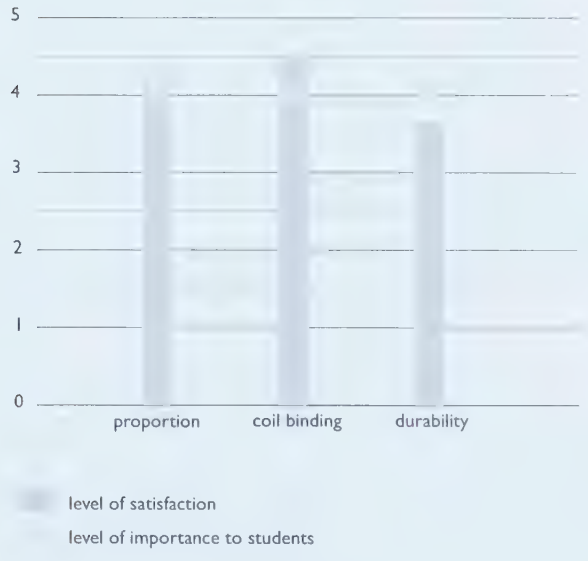
coil binding

1	*poor*	0%	
2	*fair*	0%	
3	*neutral*	0%	
4	*good*	48%	*coil binding* overall rank: 4.48
5	*very good*	52%	level of importance: 4.03

overall durability

1	*poor*	3%	
2	*fair*	14%	
3	*neutral*	10%	
4	*good*	59%	*durability* overall rank: 3.65
5	*very good*	14%	level of importance: 4.10

WORKBOOK STRUCTURE



Students' comments about the structure of the workbook remained consistent with their initial responses on the first day of class. Concerns focussed once more on the lack of rigidity of the book, and in particular, its cover. On the other hand, students provided very favourable comments regarding the coil binding since it enabled a great deal of flexibility in handling the workbook. This flexibility in manoeuvring was also observed in the class setting, as students used the workbook in a variety of different ways, such as folding it back and reading one side at a time, or by reading it flat on the desk as a double-page spread. As one student said,

> In regards to durability, it is the cover of the handbook I am concerned about. Although I am fairly careful with my with my textbooks, I have torn off much stronger covers through simply taking it in and out of my bag.... Coil binding is excellent because it cuts the desk space occupied in half, and it enables the book to lay flat at all times (an important trait). The type inside the book is a little on the small side, requiring me to lean over to read it even though I have excellent vision."

Clarity: typeface, information hierarchy, graphic images (Appendix D, p. 160)

Students were asked to rank the clarity of typography, information hierarchy, and graphic images on a scale of 1 to 5, with 1 being *poor* and 5 being *very good*. Their responses are indicated by the following percentages:

10 point Gill Sans typeface

1 *poor*	3%	
2 *fair*	0%	
3 *neutral*	3%	
4 *good*	45%	*typeface* overall rank: 4.34
5 *very good*	48%	level of importance: 4.00

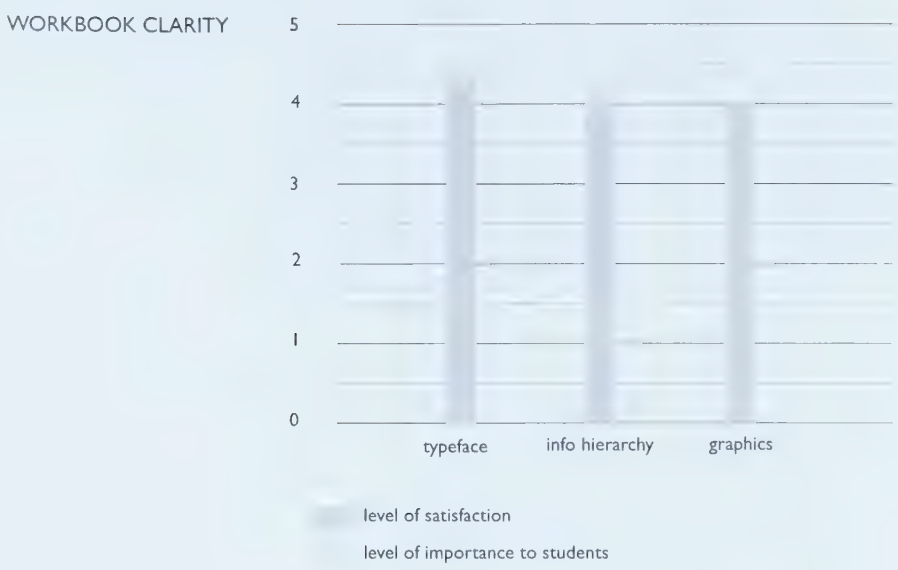
information hierarchy

1 *poor*	0%	
2 *fair*	7%	
3 *neutral*	21%	
4 *good*	28%	*hierarchy* overall rank: 4.00
5 *very good*	34%	level of importance: 4.14

readability of graphic images

1 *poor*	0%	
2 *fair*	7%	
3 *neutral*	7%	
4 *good*	50%	*readability* overall rank: 4.14
5 *very good*	36%	level of importance: 4.50

For the most part, students found that the typeface was difficult to read when it appeared against a grey background—particularly when lights were dimmed in the computer lab. Some found the graphics too small, while others felt they were useful in contributing to their learning. One student remarked that, "I like the pictures because [they help] you know for sure what it is supposed to look like and do." On



the other hand, one student felt that, "Some of the graphics are small and hard to read. The only difference this makes is that I tend to look at the diagrams—not read the words."

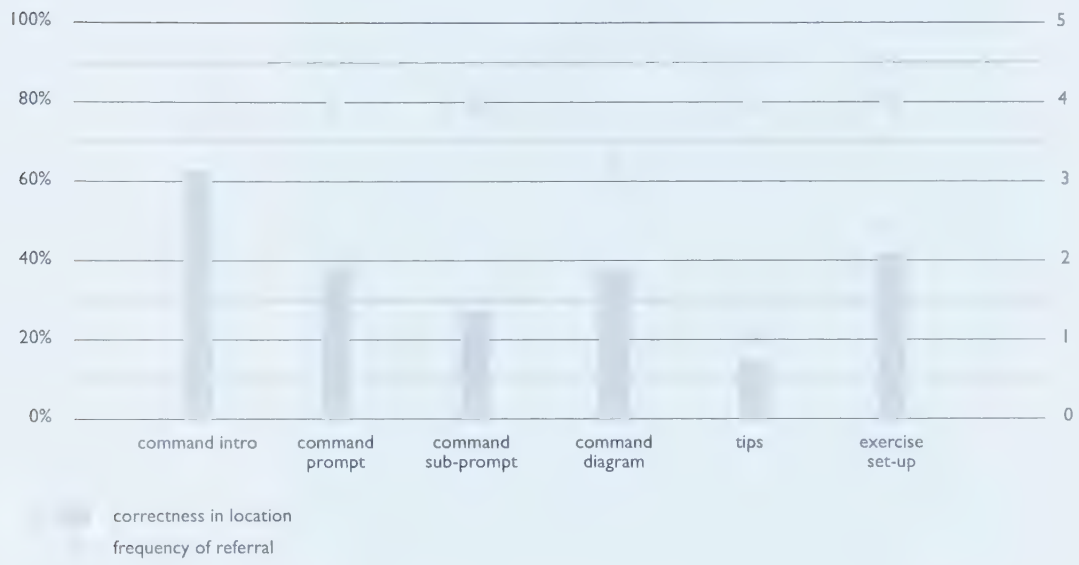
As the survey did not differentiate the kind of graphics according to their function, most students commented primarily on the images within the guided exercises. Had this question been clarified in terms of the types of graphics in the workbook, students' responses might have been more specific.

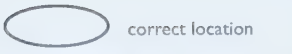
Layout predictability: command demonstration (Appendix D, p. 163)
To determine predictability of workbook layout, students were asked to indicate where they felt specific features were typically located. This was accomplished by circling an area on a graphic image representing a blank layout of the workbook. The features included *command introduction, command prompts, command sub-prompts, tips, command diagrams,* and *exercise set-up*.

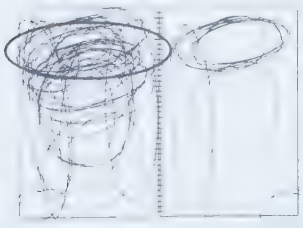
To determine how often students referred to these specific items of information, students were also asked how much they sought this information by indicating on a scale of 1 to 5, with 1 indicating *never*, and 5 indicating *always*. The following indicates percentages for students' level of accuracy for correctly identifying the location of specific items of information, as well as the average amount students referred to these items:

LAYOUT PREDICTABILITY

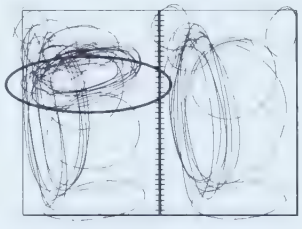
	accuracy	referred
command introduction	62%	3.75 (<often)
command prompts	38%	3.82 (<often)
command sub-prompts	27%	3.89 (<often)
tips for executing a command	31%	3.20 (>neutral)
diagrams for executing a command	14%	3.81 (<often)
exercise set-up	41%	4.03 (>often)



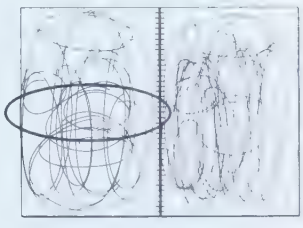




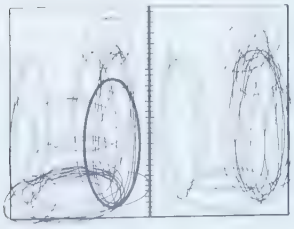
command intro



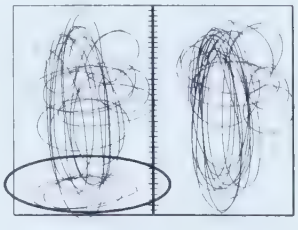
command prompt



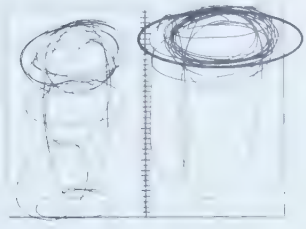
command sub-prompt



command diagrams



tips



exercise set-up

When asked to locate specific features of the workbook to demonstrate predictability of the layout and to see how often students referred to these features, it appeared that the region devoted to guided exercises was referred to most often for information pertaining to *command introduction, command activation, sub prompts, diagrams* and *tips*—information normally found on the demonstration page. For instance, when asked to locate where they could find diagrams that explained how a command works, only 14% of the respondents identified their location correctly on the right region of the left page, even though the majority of students indicated that they referred to this *often*. For the most part, students felt that these diagrams were located in the second column of the guided exercise. This was neither correct, nor incorrect, since screen shots which captured exercise progress did appear in this region. However, these images did not explicitly show the steps involved in a command sequence, as did the diagrams on the right side of the verso. Clearly, students referred less to the demonstration page for information, and more to the guided exercises to learn about a command function.

No matter how incorrect they were with respect to identifying the location of specific information, students indicated that they referred to these pieces of information *often*. Therefore, it appeared that students were satisfied that specific types of information could be reliably located, regardless of where it was intended to be located.

Layout predictability: guided exercises (Appendix D, p. 166)

In order to determine if students understood the nature and organization of the content in the guided exercise, they were asked to describe the contents in each of the columns in the guided exercises. They were also asked if they found the layout of the guided exercises helpful, and how important layout predictability was to them. Helpfulness of the layout for doing the guided exercise was ranked on a scale from 1 to 5, with 1 indicating *not helpful at all*, and 5 indicating *very helpful*. Importance of layout predictability was ranked on a scale from 1 to 5, with 1 indicating *not important at all*, and 5 indicating *very important*.

The percentages below indicate students' level of accuracy for correctly identifying the content found in each of the columns of the guided exercises:

GUIDED EXERCISES LAYOUT

	accuracy
column A (instruction)	85%
column B (visual cue)	85%
column C (command prompt)	85%
column D (explanation)	88%

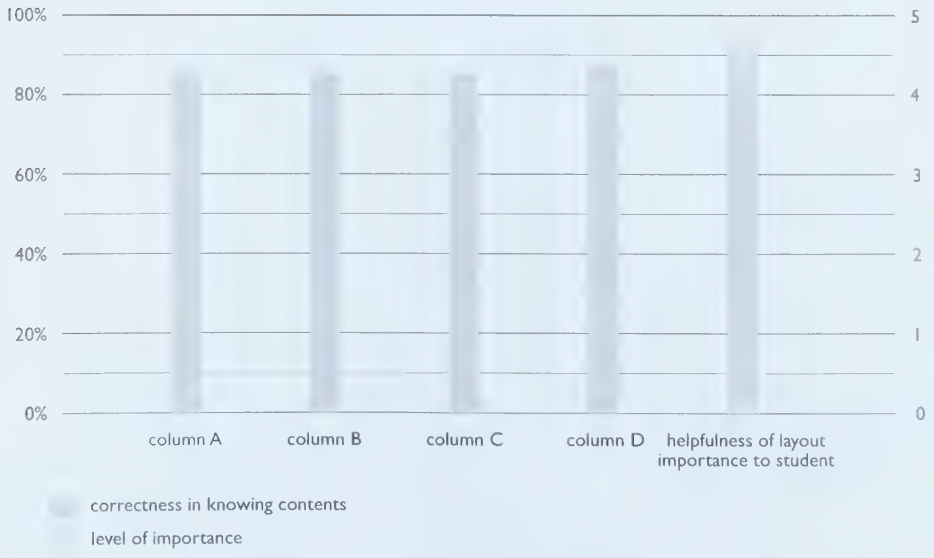
The percentages indicating the helpfulness of the layout for completing the guided exercises, as well as the level of importance for layout predicability are represented as follows:

helpfulness of layout for guided exercises

1 *not helpful at all*	0%	
2 *not helpful*	0%	
3 *neutral*	4%	
4 *helpful*	33%	*layout of guided exercises*
5 *very helpful*	63%	overall rank: 4.59

importance of layout predictability

1 *not important at all*	0%	
2 *not important*	4%	
3 *neutral*	7%	
4 *important*	32%	*layout predictability*
5 *very important*	57%	overall rank: 4.42



For the most part, students felt that the layout of the guided exercises was between *helpful* and *very helpful*, with comments such as, "I think that the set up is great, it gives you every possible way of completing an exercise in an ordered manner," and, "Excellent set up. Table format allows the user to read/follow the info best suited to their learning type. Set up well for references needed at a later date." Some suggested that a guide included at the beginning of the book would be helpful for interpreting the format of the layout, as would having extra space for students to make notes beside the columns.

Navigational devices (Appendix D, p. 168)
Students were asked to provide feedback with respect to their level of satisfaction regarding the way in which information was referenced in the workbook; how important navigation was to them; how often they used the navigational device located on outer margins; and how well they felt this device functioned. Each of these were ranked using a 5-point scale. Percentages indicating students' responses were as follows:

ease of locating specific information

1	*very difficult*	0%	
2	*difficult*	20%	
3	*neutral*	33%	
4	*easy*	31%	*navigation* overall rank: 3.30
5	*very easy*	17%	level of importance: 4.51

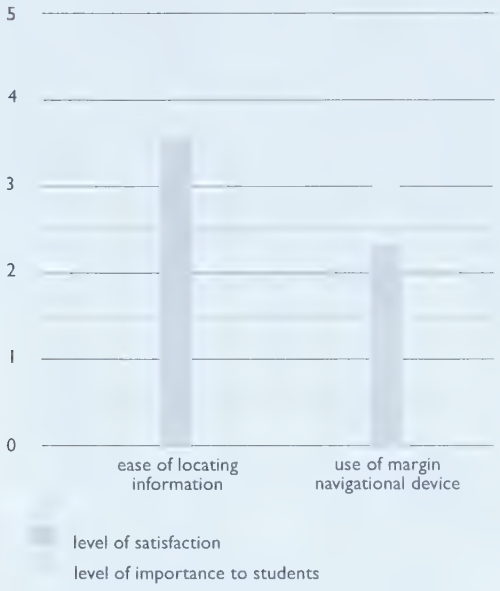
rate of use of outer margin navigational device

1	*never*	43%	
2	*sometimes*	18%	
3	*neutral*	11%	
4	*often*	14%	*use of navigational device*
5	*always*	14%	overall rank: 2.39

success of outer margin navigational device

1	*poor*	11%	
2	*fair*	14%	
3	*neutral*	46%	
4	*good*	14%	*success of navigational device*
5	*very good*	14%	overall rank: 3.07

WORKBOOK NAVIGATION



Students' comments revealed that it was difficult for them to find information such as assignments, lessons, and specific commands. As one student said,

> "While working through the book I need to constantly refer back to previous commands. I find it hard to relocate the info and the navigational device is not helpful because it is too small [and] I still need to flip so many pages to find what I need."

Students provided many suggestions, such as the need for tabs to distinguish the various lessons, page number references when a concept was being referred to in a different context, and a summary of information which is frequently called upon.

The navigational sidebar, located on the outer margin of each page, was not used as intended. As one student remarked, "I didn't notice (the side index) was there until last class!" However another student stated, "I think the navigational device is a great outline idea. I have only used it once/twice, as I knew the commands previously. However, if I had not known what to look for, I believe I would use it more. Great idea!" The measure of this response was difficult to assess however, since the intended design was not achieved by the printing service—the shaded box was to have bled off the outer margins, and used to show the locations of the lessons.

Miscellaneous issues (Appendix D, p. 171)

Students were asked to provide feedback with respect to how often they used the workbook for making notes, the limit to which they would spend on a computer manual, and their final assessment as to the overall format of the book. Students were also asked to indicate how important note-taking, cost, and visual format of the workbook were to them. Each of these were ranked on a 5-point scale. Percentages indicating students' responses are shown as follows:

workbook used for making notes

1	*never*	21%	
2	*sometimes*	3%	
3	*neutral*	7%	
4	*often*	45%	*note-making* overall rank 3.79
5	*always*	24%	level of importance: 4.00

maximum expenditure on computer manual

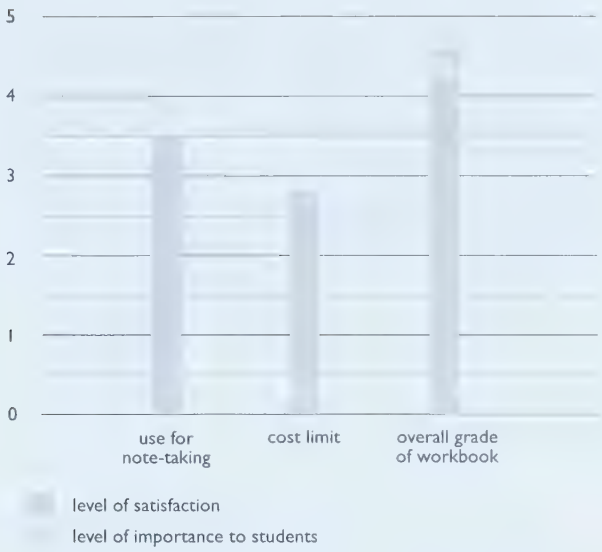
1	*$20-30*	7%	
2	*$30-40*	31%	
3	*$40-50*	38%	
4	*$50-60*	21%	*expenditure* overall rank: 2.82
5	*$60-70*	3%	level of importance: 4.31

overall grade of workbook format

1	*F*	0%	
2	*D*	0%	
3	*C*	0%	
4	*B*	41%	*visual format* overall rank: 4.58
5	*A*	59%	level of importance: 4.38

Students' final comments and suggestions emphasized the need for a more durable cover, a method for distinguishing lessons, and better access to the information. They favoured the coil binding, the numerous graphic images, and the structured layout. A telling comment came from one respondent who remarked:

> Visual images work well (a picture is worth a thousand words). I like the fact that images and/or words are not crammed together. Instead they are comfortably surrounded by a visually pleasing amount of negative space (and psychologically less intimidating). The cover needs to be stronger. It's a good manual and I would like it to last.



The comments provided in the survey questionnaires were reiterated by the various focus groups. Their suggestions for improving the visual design included increasing the size of the typefaces, particularly in the guided exercises; emphasizing the *Command prompt* information on the demonstration page by increasing the size of the icon; demarcating each lesson and the location of assignments; as well as providing a cover which was more rigid; a place to contain hand-outs and class notes; and a 'quick reference' guide for often-used commands and drawing set-up information. Another student suggested a specific area in which to write notes.

When queried about the lack of success of the navigational device on the outer margins, students agreed that its contents were difficult to read—particularly in a darkened lab setting. Although some suggested the use of more colour as a means to dramatize certain features, others were less inclined to promote this if the inclusion of colour would increase the cost of the workbook beyond their budget.

By observing the workbook in use, the need for additional alterations to visual design features became apparent. First, the visual weight of the first page of the guided exercises appeared overwhelming, and countered the intended lightness of the layout. Second, the image in the top right corner of the guided exercise was neither anchored its position, nor clarified as to its purpose. Third, the information pertaining to the purpose of the guided exercise and the necessary requirements lacked immediacy by being set in paragraph form. Finally, the topic headings for each new command lacked emphasis and therefore seemed to go unnoticed.

Response to visual design test results (Appendix B, p. 108)
In response to these findings, and to complete the contents of the curriculum, the second prototype was created. Due to financial constraints imposed by the students' budgets and time constraints imposed by having to meet the second prototype deadline, some revisions were reserved for the third iteration of the project—including the provision of an index, a quick reference guide, coloured tabs and a more rigid cover. Nonetheless, the second prototype was created with the following modifications:

To increase legibility:

- body typeface size and leading was increased from 10/12pt. to 11/13pt.
- *Courier* typeface in the guided exercises was bolded
- grey values in the guided exercises were diminished by 10%
- sub-headings pertaining to command prompt variations were changed from regular to bold
- screen capture images below the command prompt variations (icons and menus) were increased in size

To distinguish features:

- rigid, over-sized (8½ x 12") lesson dividers were added to distinguish each module
- pages containing lesson assignments were changed from white to 20% grey
- lines, for written notes, were added to '**d**|brief pages'
- steps in the guided exercise on the first page were reduced from five to four, creating space to reposition the final image of the exercise, and to lighten the visual weight imposed by the five steps
- text introducing the guided exercise was set as a numbered list to provide more immediate access to the information
- title headings for each command was changed to 20% grey and increased from 18pt to 36pt to emphasize the beginning of a lesson
- initial verb within title headings were offset in its alignment to the noun
- 'tips' section of the demonstration page was relocated to the end of the guided exercises under a new heading called '**b**|aware'
- 'Flying solo' was changed to '**c**|what you know' to be consistent with '**a**|ssignment', '**b**|aware', and '**d**|brief features'

Instructional design test results (Appendix D, p.174)
Additional observations made while the workbook was being used pertained to how various students approached the workbook for learning AutoCAD. These observations generated concerns and queries which formed the basis of the final survey questionnaire pertaining to the workbook's functionality. This was administered to measure how well the workbook functioned for teaching the necessary skills to generate a set of architectural drawings.

At the beginning of the first class, students appeared somewhat hesitant in their use of the workbook. Although it was written and designed for students to begin using it immediately, it was not until approximately page 27 that students began to spontaneously refer to the workbook for additional or confirming information. Prior to this, it was observed that students initially looked to the instructor for guidance, and clarified instruction by writing notes in another source (many students brought a notebook to the first class). As early as the second lesson however, students began working independently from the instructor, and appeared to use the workbook as a tool for communicating with themselves and to others. This was due in part to the instructor's insistence on students following the guided exercises, and to her strict adherence to the instructional format.

The first two lessons seemed to present the most user-errors in misreading or misinterpreting instructions in the guided exercises. Which instruction caused the confusion was not apparent—each student appeared to interpret an instruction uniquely. In some cases, students would miss entire steps. In other instances, students entered wrong commands. These events were consistent with Carroll's observation that errors occur because of learners misreading, following an incorrect sequence of steps, or by hitting an incorrect key. (Carroll 1999, p. 34). In any case, user-errors occurred despite clear, error-free instructions.

In order to counter these errors, students either turned to a peer for clarification, attempted the step once more, or scrutinized the contents of the guided exercise to see where their screen and/or command line did not align with that of the workbook exercise. If none of these strategies seemed to help them to resolve their problem, an instructor was consulted.

By the third lesson, students began to develop independence and automatic strategies for learning and using AutoCAD, with many of the basic operations appearing to become second nature. Within the first

two weeks, all students successfully completed two relevant drawings assignments consisting of the most frequently used commands: *line, snap, erase, offset, trim,* and *extend*. As a result, students appeared to rely on the workbook more: the instructor was called on less frequently to resolve difficulties, and students appeared to develop their own pace for learning. Some students still chose to follow along with the demonstration by the instructor, while others chose to work through the contents of the lesson independently.

This independence from the instructor was not without its difficulties, especially in the earlier part of the course. As previously stated, the instructor controlled the pace of instruction for each lesson by initiating new topics once most students appeared to have completed the guided exercise from the previous topic. Unfortunately, in some instances, some students were still engaged in the previous guided exercise when the instructor initiated the next topic. These students found it difficult to incorporate the new information while still trying to understand the previous command. As a result, students expressed frustration and concern that some topics were proceeding too rapidly.

This problem appeared to be due partly by instructor pacing, and partly by the lesson structure of the workbook. For example, the first part of lesson three required students to draw a series of furniture elements to review the previous two lessons, as well as to create drawings that would be used as a basis for exercises within the new lesson. After allowing thirty minutes to complete the initial drawing, the instructor initiated the first demonstration for the command *move*. After the demonstration however, most students did not advance to the guided exercise, but rather, returned to the warm-up assignment. Likewise, after the *rotate* command demonstration, only six of the seventeen students in the lab proceeded to the guided exercise. Seven students returned to finishing the initial drawing, two students generated their own practice exercise, and one student worked ahead. This pattern continued, until students either finished the warm-up drawing, or had devised their own method of practicing the command. After the instructor had demonstrated all of the commands of the lesson (within a two-hour and forty-minute period) students expressed being overwhelmed by both the pacing and the amount of information they had absorbed. In the end, the lesson was not fulfilled as intended, creating the impression that this lesson either contained too much information for delivery within a single lab period, or that the demonstration of the commands occurred too rapidly.

Ultimately, all students successfully fulfilled the assignment requirements for lesson three, suggesting that they eventually understood the concepts presented in that module. This generated the impression that students were able to acquire the necessary skills in a manner that was less dependent upon the instructor. That the workbook served as a tool for independent learning was even more evident in lesson five. It was this lesson that presented an advanced concept for plotting drawings that was new even to the AutoCAD instructors, since they were aware only of the former method of plotting drawings from earlier versions of AutoCAD. As such, their only means for understanding the idiosyncrasies of plotting drawings was by working through the guided exercises of lesson five on their own and completing the accompanying assignment. Both instructors reported that they had completed the guided exercises and successfully fulfilled the requirements of the assignment in less than three hours. They felt confidence enough to teach this lesson to the students.

By the sixth lesson, after students received all the fundamental commands for drawing with AutoCAD, 14 out of 36 students chose to use AutoCAD to complete a complex assignment in another course. This assignment involved over ten sheets of construction drawings for a custom-designed playhouse. This was a new phenomenon, and demonstrated that students were developing both confidence and competence in using AutoCAD. As the course progressed through the semester, attendance in the lab decreased. By the last four weeks of classes, an average of 50% of students attended the full four-hour class. Despite diminished attendance however, students were still able to meet or exceed assignment requirements.

Although in-class observations provided insights as to how the workbook was being used, it was difficult to determine what elements contributed best to student learning. An area of concern was if the guided exercises were a useful resource for making connections regarding the functioning of AutoCAD commands, or if they were merely fostering rote responses. As such, the final survey questionnaire regarding the instructional effectiveness of the workbook was administered in order to find out.

This questionnaire was distributed one week before the end of the AutoCAD course, when most students had acquired all the skills necessary to complete their final assignment. Unfortunately, this came at a time when pressures from other courses were also considerable. As a result, only 16 of 36 surveys were completed.

Nonetheless, the responses clarified how the workbook was used, and whether it facilitated comprehension of AutoCAD. This questionnaire was broken down into areas pertaining to *instructional efficacy; content and organization; exercises and assignments; learning styles; independent learning; and miscellaneous issues*. Students provided qualitative feedback by ranking the workbook's instructional design on a series of 5-point scales, as well as qualitative feedback by way of comments and suggestions.

Instructional efficacy (Appendix D, p. 174)
The first portion of the survey examined the basic efficacy of the workbook. It determined students' level of confidence in their understanding of AutoCAD; the degree to which students felt that the workbook was useful for learning how to create a set of architectural drawings; and how much the workbook contributed to their skill development. Each of these were ranked on a 5-point scale. The following percentages indicate students' responses:

confidence level with AutoCAD

1	*not very confident*	0%	
2	*not confident*	6%	
3	*neutral*	19%	
4	*confident*	69%	*confidence*
5	*very confident*	6%	overall rank: 3.75

usefulness of workbook

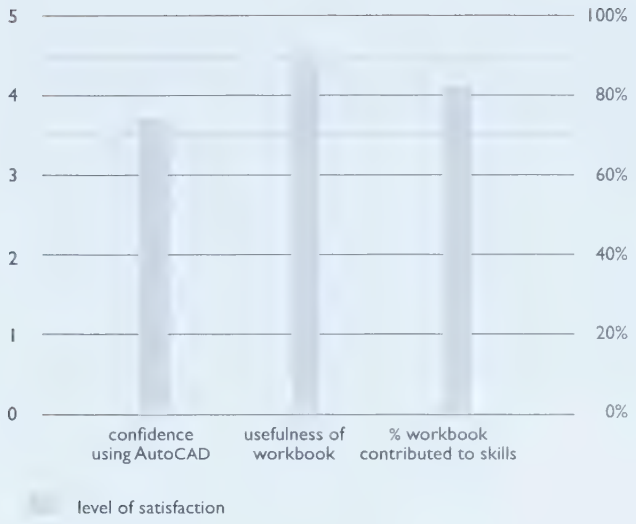
1	*not useful at all*	0%	
2	*not useful*	0%	
3	*neutral*	6%	
4	*useful*	44%	*usefulness*
5	*very useful*	50%	overall rank: 4.43

% workbook contributed to skills

1	*0%*	0%	
2	*25%*	0%	
3	*50%*	27%	
4	*75%*	33%	*contribution*
5	*100%*	40%	overall rank: 4.13

In response to the query regarding their skills, most students replied that, although they knew how to use AutoCAD, they also realized there was so much more to learn. As one student wrote, "Because there are a couple of commands (i.e. *chamfer*) that I'm not in the

WORKBOOK EFFICACY



practice of using very much I don't know how to use them properly. Overall I like the program and feel I can run it well." Others indicated that they did not fully know specific concepts, but understood that skill development was acquired through practice and referring to other sources, "I really like AutoCAD. I know I will feel quite confident when I spend more time on it from a day to day basis," and, "I feel the workbook has helped increase my skills, and I know enough to figure things out on my own."

Although students ranked their confidence with AutoCAD as slightly below *confident* (3.75), their grades provided evidence to the contrary. The grade point average for this set of respondents was B+ a grade that is higher than average skill level according to the academic standards of Mount Royal College.

With respect to the usefulness of the workbook as a tool for learning AutoCAD, students offered positive feedback such as, "Although I prefer learning by example, the textbook is so basic and step-by-step that I find it easy to follow." One student provided this comparison, "The help tool in AutoCAD does not explain the functions well, nor is it user-friendly. The workbook provides simple easy to understand language."

In regard to the degree to which the workbook contributed to their learning, students offered comments such as, "I feel I could have learned this just by the workbook," and "It's easy to see, read and understand, rather than watching someone do it, it is laid out step-by-step in front of you allowing one to work at their own pace." Others clarified that the instructor was also responsible for their skill development, as this student observed: "The teaching is very important to see

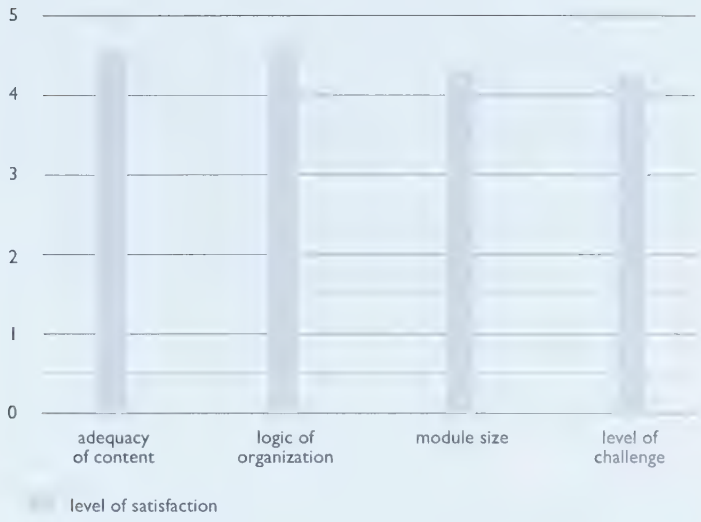
first. But the book makes the knowledge sink in." Others though, were concerned that in order to reinforce skills, the AutoCAD course needed to occur more often than once a week, and more practice exercises could have been included.

Content and organization (Appendix D, p. 177)
Students were asked to rank the adequacy of the workbook's contents, organization, pacing, and its level of challenge on a scale of 1 to 5, with 1 indicating *no*, and 5 indicating *yes*. The following percentages indicate students' responses:

adequacy of content			
1	*no*	0%	
2	*not really*	0%	
3	*neutral*	12%	
4	*for the most part*	19%	*content*
5	*yes*	69%	overall rank: 4.56
adequacy of content organization			
1	*no*	0%	
2	*not really*	0%	
3	*neutral*	6%	
4	*for the most part*	31%	*organization*
5	*yes*	63%	overall rank: 4.56
adequacy of content pacing			
1	*no*	0%	
2	*not really*	6%	
3	*neutral*	6%	
4	*for the most part*	38%	*pacing*
5	*yes*	50%	overall rank: 4.31
adequacy of challenge			
1	*no*	0%	
2	*not really*	6%	
3	*neutral*	6%	
4	*for the most part*	44%	*challenge*
5	*yes*	44%	overall rank: 4.25

Students appeared satisfied with the workbook's content, its organization, pacing, and the degree of challenge presented by the content. Most students realized that they possessed the necessary skills for computer architectural drawing, but that there was more to learn. For

WORKBOOK CONTENT + ORGANIZATION



instance, one student remarked that, "I think there are probably short cuts and tricks we'll learn later, but we know enough now to do a set of drawings." Others pointed out that they had enough knowledge to complete an additional set of construction drawings for a class outside of the AutoCAD course, indicating that they had indeed received adequate content to achieve this goal.

Suggestions for improvements to the organization of the content were few, but of the comments made, most focussed on alterations to the workbook's visual design (such as tabs to distinguish lessons) rather than its curriculum. Comments that did pertain to the organization of the content were positive, such as, "Progressed nicely", and "It was gentle in its guidance."

Comments regarding the pacing of the materials were also positive, however one of the students felt that, "Sometimes too much was learned in one day resulting in my forgetting some information." Another student clarified that the pacing in the book was fine, but, "in class, no."

When asked to comment on the level of challenge the instruction presented, students offered differing perceptions. One student said that the course was, "Not really challenging." Someone who was satisfied, said, "The book was so easy to follow there was no room to be confused or overwhelmed." However, another student remarked that, "The pace was sometimes too fast."

Usefulness of guided exercises and assignments

Students were asked to rank the usefulness of the guided exercises and assignments on a scale of 1 to 5, with 1 indicating *not useful at all*, and 5 indicating *very useful*. In addition, students were asked how often they completed the guided exercises by using a 5-point scale which was differentied by extremes of *never* and *always*.

The following percentages indicate students' responses:

guided exercises

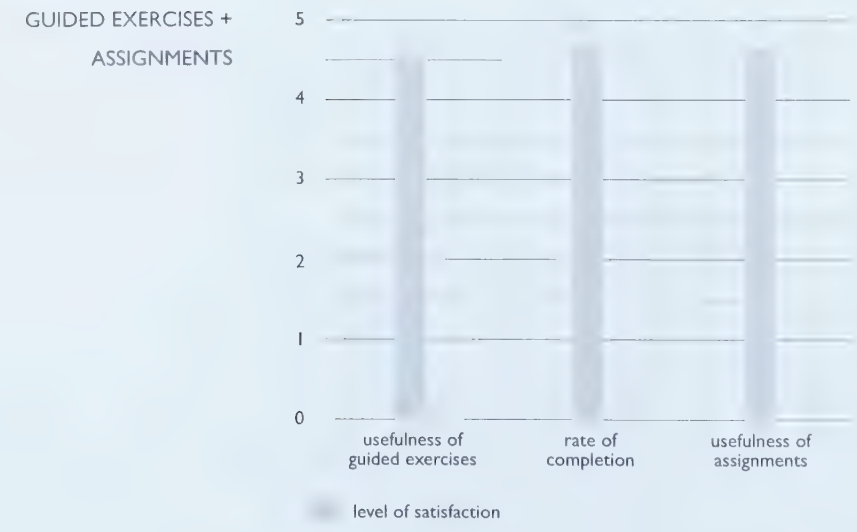
1 *not useful at all*	0%	
2 *not useful*	0%	
3 *neutral*	12%	
4 *useful*	19%	*guided exercises*
5 *very useful*	69%	overall rank: 4.56

completion of guided exercises

1 *never*	0%	
2 *not often*	0%	
3 *neutral*	6%	
4 *most of the time*	25%	*completion*
5 *always*	69%	overall rank: 4.62

assignments

1 *not useful at all*	0%	
2 *not useful*	0%	
3 *neutral*	14%	
4 *useful*	53%	*assignments*
5 *very useful*	33%	overall rank: 4.62



When questioned as to how these guided exercises could be improved, a variety of responses were given. These ranged from increasing the typeface, to having the instructor do the steps aloud, to shortening them somewhat. One student remarked that, "...sometimes there would be the tiniest detail missing which would throw you off." At the same time however, two students indicated that they did not require improvement, and that, "I think they're excellent the way they are."

Assignments generally received favourable comments from students, such as, "They were great in helping me to develop the skills I had acquired from the text." One student felt that, "By doing the assignments, even several times, it made you analyze the different ways you can come about building a drawing." This same student elaborated however, that smaller assignments should be incorporated "...in the beginning of the term so that there is more constant use of the basic commands."

Provision for learning and error recovery (Appendix D, p. 181)
Students were asked to rank their first, second, third and fourth choices with respect to the feature of the workbook that best contributed to their understanding of AutoCAD. These features included *guided exercises, assignments, instructor input,* and *working things through with classmates.* Students were also asked to rank their preferred methods for recovering from errors, to determine if the workbook provided adequate means to recover from errors. These methods included *consulting with classmates or instructors, referring back to the workbook, experimenting with other options,* or *going on to the next exercise.*

The following percentages indicate how students responded to questions pertaining to features which best contributed to learning and error recovery:

Feature which best contributed to learning:

	1st choice	2nd choice	overall rank
working with classmates	0%	38%	2.12
instructor input	31%	0%	2.18
assignments	31%	31%	2.75
guided exercises	38%	31%	2.97

Error recovery: guided exercises

	1st choice	2nd choice	overall rank
consulting others	25%	44%	2.87
referring to workbook	56%	25%	3.31
experimenting	19%	31%	2.62
going on to something else	0%	0%	1.81

Error recovery: assignments

	1st choice	2nd choice	overall rank
consulting others	19%	38%	2.68
referring to workbook	62%	25%	3.37
experimenting	19%	31%	2.62
going on to something else	0%	6%	1.31

These scores suggest that both the guided exercises and solo assignments were the most helpful in contributing to the students' understanding of AutoCAD, and that the workbook served as students' first choice for helping them recover from errors.

Provision for learning styles (Appendix D, p. 181)
In order to determine preferred style for learning AutoCAD, students were asked to rank the techniques which seemed to contribute most to their learning of AutoCAD. The following learning preferences were indicated by students

engaging in dialogue and sharing ideas (diverging)	18%
listening closely to instruction (assimilating)	38%
problem-solving and tinkering (converging)	38%
trusting intuition and taking chances (accommodating)	6%

When asked about their preferred style for acquiring AutoCAD skills, only 2 of the 16 students matched their original learning profile. In fact, a majority of the students shifted to a profile which reflected the learning domain of AutoCAD: that being, a problem-solving activity incorporating abstract concepts. It appeared that, despite the original learning style, a certain preference for learning appeared to align with the character of the content matter. Regardless of the original learning style profile, the features that contributed most to learning were those activities that reinforced learning through assimilation (the guided exercises) and learning through convergence (the assignments). This hypothesis warrants closer scrutiny however, since a full *Learning Style Inventory* was not administered in the final questionnaire.

After examining final grades in relation to original learning profiles, there did not seem to be a correlation between achievement and a specific learning profile. In other words, students who originally demonstrated a propensity for convergent learning, did not necessarily score better because they were learning content that involved problem-solving using abstract concepts. In fact, the average grade achieved for the *convergent* learning profile was 2.92, compared to 2.96 for the *divergent* learning profile, 3.01 for the *assimilating* learning profile, and 3.28 for the *accommodating* learning profile—grades all within the 'B' range. This was perhaps an indication that although one learning profile may be predisposed to a particular learning domain, other factors for successful learning may have to be considered—including levels of anxiety, motivation, prior education, and predisposition to the material being taught.

Workbook as a tool for independent learning (Appendix D, p. 183)
In order to determine if the workbook was a reliable tool for independent learning, students were asked to indicate how often they used the workbook to either catch up on content, or to work ahead. On a scale of 1 to 5, with 1 indicating *never* and 5 indicating *always*, students provided the following scores:

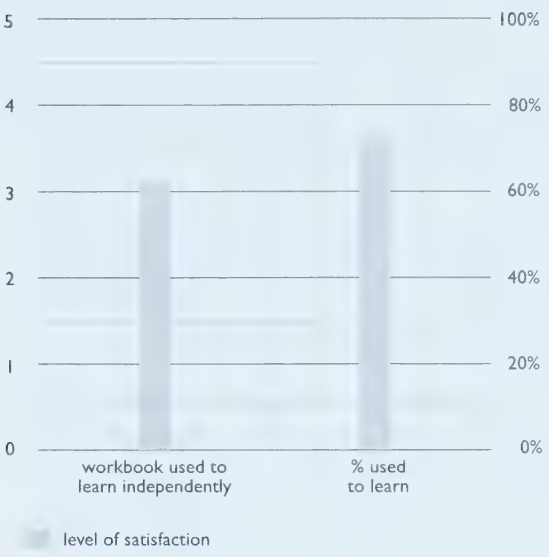
1	*never*	12%	
2	*not often*	19%	
3	*neutral*	19%	
4	*often*	38%	*independent learning*
5	*always*	12%	overall rank: 3.18

When asked to provide a ratio between use of the workbook and instructor input to indicate how they acquired their skills in AutoCAD, most students indicated that the workbook was primarily responsible for teaching them to use AutoCAD. The results were as follows:

1	*100% workbook*	6%
2	*75% workbook*	50%
3	*neutral*	38%
4	*75% instructor*	6%
5	*100% instructor*	0%

Students elaborated by stating that, in addition to input from the instructor and referring to the workbook, they learned by watching others and through practicing on their own. For the most part, they felt the workbook was an important component for learning AutoCAD.

INDEPENDENT LEARNING



In order to determine if it would be feasible to run an AutoCAD course whereby students learned primarily through the workbook, students were asked if they would purchase AutoCAD software to learn on their own time. Sixty per cent of the students replied that they would. Students were also asked to provide suggestions regarding how an independent course could be best facilitated. Their suggestions varied, but most indicated that information or services supplemental to the workbook were needed. These included access to personal assistance, a CD-ROM to teach commands, graphic examples on a computer showing different commands in action, and more practice exercises.

Learner attitude

Regarding their level of anxiety and attitude toward learning AutoCAD, students were asked, once more, to provide their perceptions regarding the level of difficulty of AutoCAD, as well as to indicate their attitude toward learning the material. Generally, students were more positive about learning AutoCAD than they had initially reported. The mean score, reflecting students' attitudes prior to commencing the AutoCAD course, increased from 4.15 to 4.37, indicating that they were slightly more positive about learning AutoCAD. Thirty-seven percent of these respondents changed their attitudes from their initial response, with 83% of these changes being more positive. Students provided the following responses with respect to their attitudes for learning AutoCAD:

MISCELLANEOUS ISSUES

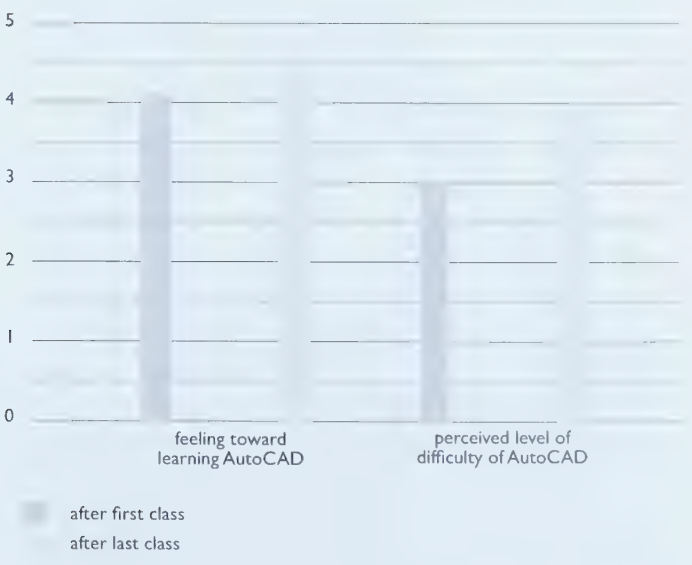
1	*very negative*	0%	
2	*negative*	6%	
3	*neutral*	0%	
4	*positive*	38%	*attitude after AutoCAD course*
5	*very positive*	56%	overall rank: 4.37

According to their comments, most students reported feeling *positive* about learning AutoCAD because of the benefits it afforded them. Specifically, students stated that, "It's worth learning, easy to learn and efficient," and, "I really enjoy it. I prefer it far beyond hand drafting. I am looking forward to doing CAD in my work term."

Students' perceptions regarding the difficulty of AutoCAD also changed. Originally ranked at 3.06, students now ranked AutoCAD at 3.93, indicating that learning AutoCAD was *somewhat easy*. In this case, 81% of the respondents changed their attitude, with 76% of this group saying that AutoCAD was easier than they had originally anticipated. The ranking of AutoCAD's level of difficulty was perceived as follows:

1	*very difficult*	0%	
2	*difficult*	18%	
3	*neutral*	6%	
4	*easy*	38%	*perceived level of difficulty*
5	*very easy*	38%	overall rank: 3.93

LEARNER ATTITUDE



Additional comments

When asked to comment on how the workbook's curriculum could be improved, students' suggestions generally focussed on its visual design. Students requested a way to access the lessons more easily, a way to reference specific information in the workbook, and a means to quickly reference commonly used features. They also stressed the need for a more durable cover. Learners did identify visual elements as helpful in improving their comprehension of the content.

With respect to final comments by the instructors, both expressed that the workbook augmented their instruction more effectively than the previous manual. They were aware of having more time to spend with students who required extra tutoring by realizing that students were able to use the workbook as a primary resource for learning. The workbook provided a valuable 'script' for the curriculum, which as one instructor indicated, kept both instructor and student 'on the same page'.

Response to instructional design test results

In light of the information gathered from questionnaires, focus groups, in-class observations and informal discussions, a third iteration of the workbook will be prepared in time for the next AutoCAD course which runs in the winter semester in of 2003. The changes to the instructional format will be minimal, since the topics included, the manner in which they were sequenced, and the type of guided exercises and assignments appeared to successfully facilitate learning AutoCAD. Lesson three however, will be broken down into two components, with the option for it to be taught over a single class period. This change is in response to students' perceptions that this lesson was too overwhelming in the scope of its content.

Based on suggestions by both the instructors and the students, the visual design of the workbook will also be further modified. To facilitate easy access to information, an index of all commands and their operations will be added to the back of the book. The navigational device originally located at the outer margins will be reinstated, but this time with more legible type, and situated on the page so that its location is apparent when the book is closed, thereby signalling the location of each lesson. Both front and back covers will be printed on more rigid material, and folded to create a pocket on their inside faces. The pocket on the front cover will contain a quick-reference card (**e**|ssentials) detailing commonly used commands and information

which is frequently sought. Finally, to provide a greater sense of contrast and interest, the title of each heading will incorporate a more dynamic typographic structure to emphasize its place and meaning.

Being an iterative design problem, these improvements will not signal the end of this project. Rather, modifications both great and small will continue to be implemented through a continued process of observation and feedback. As Carroll stated in *Beyond the Nurnberg Funnel,* "...there can not be an ending to the project of learning how to design information. We do better, but we can do better still." (Carroll 1999, p. 12)

CONCLUSION

The core purpose of the Interior Design AutoCAD curriculum at Mount Royal College is to provide basic skills in AutoCAD such that students are able to draft a complete set of architectural drawings within a 15-week semester. Therefore, both the design of the instruction and the AutoCAD workbook aimed to meet this primary objective.

This was accomplished. Thirty-five of the 36 students enrolled in the course received a passing grade, achieving a class average of 3.06 out of a possible grade point average of 4.0. All students successfully fulfilled assignments' expectations, with 47% of the students exceeding course requirements by earning a grade of B+ or better. This was a result of students being less dependent upon the instructor for learning the material, and more reliant on the workbook for both guiding their learning and serving as a resource to resolve errors. In the end, students felt that learning AutoCAD was easier than they had anticipated, and were generally motivated to continue learning and using AutoCAD because it was enjoyable to use and was relevant to their drawing needs.

Although underlying philosophies regarding Kolb's learning styles were integrated in the curriculum, survey results did not indicate this to be a significant factor in facilitating students' success, or in enhancing their learning experience. Rather, it appeared that the successful outcome was a result of an instructional design that was relevant to the needs of users; that enabled students to become productive immediately; was sequenced logically in a manner that did not tax the cognitive load; and provided worked examples to hone problem-solving techniques and help learners recognize and remedy errors.

The success of the project also appeared to be due, in large part, to the format of the visual communication: the structure was ergonomically conducive to reading; its layout was organized, logical and clear; the use of images and graphic elements facilitated efficient interpretation; and the overall character was congruent with the nature of the instruction and the profile of the learners.

As previously stated, the success of a usable product, particularly in the case of instructional materials for a computer application, is

dependent upon an iterative process that is centred around those who will use it. As a result, the cycle of problem identification, problem analysis, clarification of design objectives, implementation of design strategies, and evaluation of design resolutions—in other words the activities undertaken to develop this project—will need to be revisited. As AutoCAD continues to improve upon its interface and users become more developed in their computer prowess, this workbook must continue to evolve accordingly.

Due to its interdisciplinary nature, this project was broad in its scope. This is a condition of all visual communication design projects. As Bernd Meurer proposed in *User-centred graphic design*, visual communication design "...is a problem-oriented, interdisciplinary, creative action... a crossing point of a number of disciplines which converge to create communicational objects to address human problems." (Frascara 1997, p. 2). As a result, a number of domains in this project converged in order to create a product which is useful, easy to learn, and satisfying to use.

The design of the AutoCAD workbook was dependent upon the simultaneous planning of both the curriculum and visual format. It became evident that the success of the instruction was inextricably linked to the manner in which it was presented visually, and the quality of the design was dependent upon the content and organization of the curriculum. In other words, if the curriculum lacked cohesion, rhythm, and logic, this would have surfaced in the resulting visual statement. If the visual statement was illegible, illogical, and incongruent in its character, the instruction would have been rendered unintelligible. Form and content were equally important in creating a product that enabled students to develop the necessary skills in a way that was efficient, meaningful, and satisfying.

This would suggest that, rather than distinguishing visual communication and instructional design as two separate activities, with one playing a more substantive role than the other, both activities should be considered as equally important for implementing a successful curriculum. Just as it is important to possess both written and spoken communication skills for teaching in the classroom, it may be desirable that an instructor should also possess the necessary skills to interpret and compose visual elements in order to communicate content effectively —particularly where visual media form the basis in which instruction is conveyed, as is the case with learning computers through self-instruction.

Is it unreasonable to expect domain specific experts such as instructional designers to become visually literate in order to create an instruction cohesive in its form and content? The results of this project may demonstrate otherwise. Just as visual design programs throughout North America typically involve course work in other disciplines to foster a broader awareness in other domains (such as the social sciences, business, and computer science), the results of this research project would suggest that the converse should also occur, whereby all students develop the essential visual vocabulary and grammar to effectively compose their ideas, goals, and concepts. As Jerome Bruner remarked,

> Teaching is vastly facilitated by the medium of language, which ends by being not only the medium for exchange but the instrument that the learner can then use himself in bringing order into the environment. (Knowles 1978, p. 8).

If we are to adapt successfully to a world which is becoming increasingly dependent upon visual media to learn, to stay informed, to be healthy, to keep safe, or to be entertained, it is imperative to extend skills in visual literacy to a broader population—and not just those with an inclination for visual expression.

APPENDIX **A**

initial workbook design

LAYOUT GRID

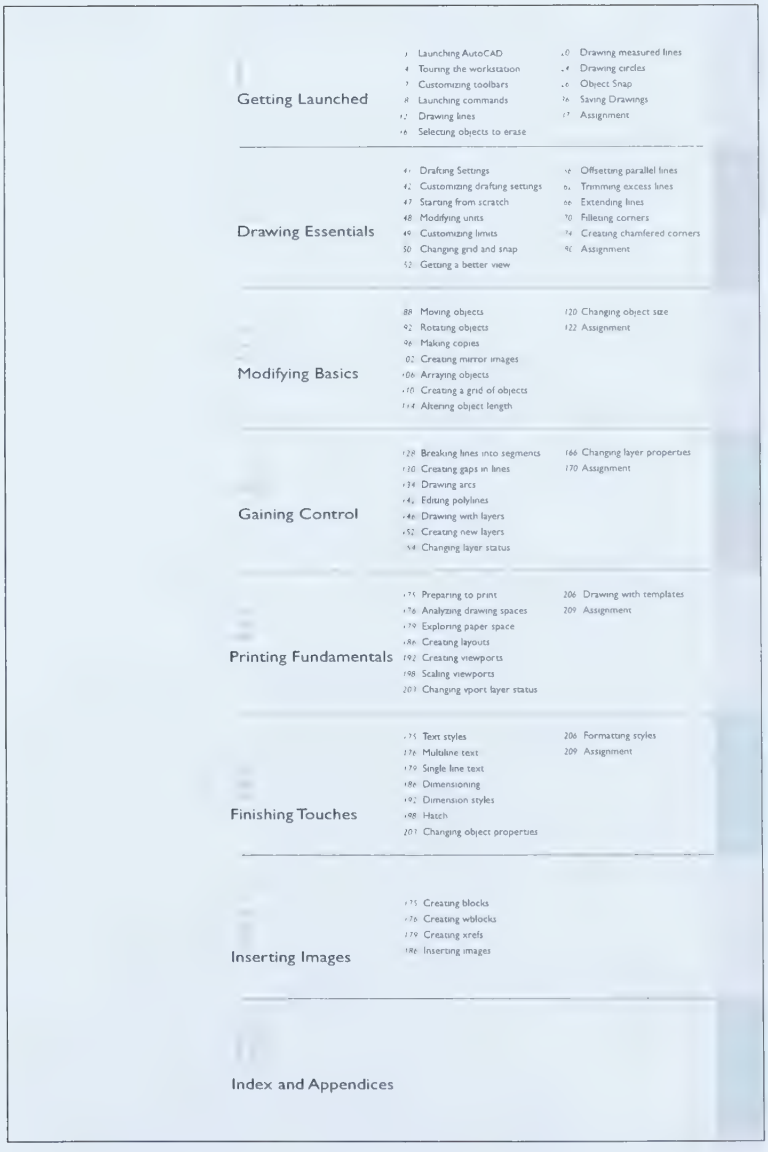
- *8 x 12" layout*
- *8 column, 8 row grid*
- *54pt inside margin, 36pt outside, top, and bottom margins*

WORKBOOK COVER

- *workbook title*
- *student identification label*
- *image of AutoCAD cursor and CAD drawing*

TABLE OF CONTENTS

- *lesson number*
- *lesson title*
- *topic names and assigned pages*
- *horizontal lines and grey boxes aligned with lesson navigation device*



Getting Launched
1 Launching AutoCAD
4 Touring the workstation
7 Customizing toolbars
8 Launching commands
12 Drawing lines
16 Selecting objects to erase
20 Drawing measured lines
24 Drawing circles
26 Object Snap
36 Saving Drawings
37 Assignment

Drawing Essentials
41 Drafting Settings
42 Customizing drafting settings
47 Starting from scratch
48 Modifying units
49 Customizing limits
50 Changing grid and snap
52 Getting a better view
58 Offsetting parallel lines
62 Trimming excess lines
66 Extending lines
70 Filleting corners
74 Creating chamfered corners
80 Assignment

Modifying Basics
88 Moving objects
92 Rotating objects
96 Making copies
102 Creating mirror images
106 Arraying objects
110 Creating a grid of objects
114 Altering object length
120 Changing object size
122 Assignment

Gaining Control
128 Breaking lines into segments
130 Creating gaps in lines
134 Drawing arcs
142 Editing polylines
146 Drawing with layers
152 Creating new layers
158 Changing layer status
166 Changing layer properties
170 Assignment

Printing Fundamentals
175 Preparing to print
176 Analyzing drawing spaces
179 Exploring paper space
186 Creating layouts
192 Creating viewports
198 Scaling viewports
203 Changing vport layer status
206 Drawing with templates
209 Assignment

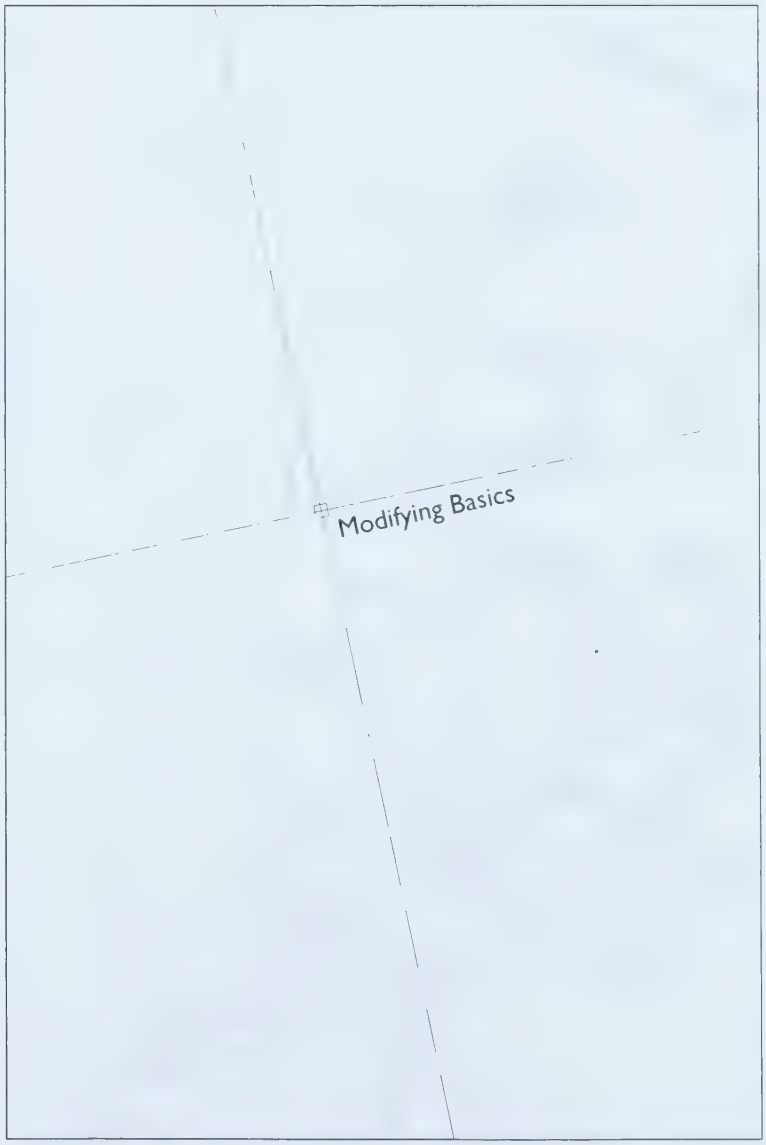
Finishing Touches
215 Text styles
216 Multiline text
219 Single line text
186 Dimensioning
192 Dimension styles
198 Hatch
203 Changing object properties
206 Formatting styles
209 Assignment

Inserting Images
175 Creating blocks
176 Creating wblocks
179 Creating xrefs
186 Inserting images

Index and Appendices

LESSON DIVIDERS

- *lesson number*
- *lesson title*
- *image of AutoCAD cursor and CAD drawing*
- *diagonal line aligned with lesson navigation device*



DEMONSTRATION

command introduction

- *command heading*
- *description of command function*
- *images pertaining to command function*

creating MIRROR IMAGES

The *Mirror* command allows you to create a mirror image of your drawn objects. This is helpful when drawing symmetrical elements — just draw one side of the axis, and mirror those objects to complete the drawing.

command prompt methods

- *methods for initiating commands*

COMMAND PROMPT

icon	menu	command
modify toolbar	Modify > mirror	`mirror` or `mi`

command sub-prompts steps

- *command sub-prompt requests*
- *responses required*
- *sample diagrams*

SUB-PROMPT *Select objects.*
Select the objects to be mirrored
Hit enter once object has been selected

Consider the placement of the mirror should be halfway between the ...orance from the mirrored object.

Specify first point of mirror line:
The mirror line is the axis of symmetry about which your object will be mirrored. **Pick** the first point on the mirror axis

1st point of mirror line

The distance of the mirror line is not important — only the direction of its axis.

Specify second point of mirror line.
Pick the end point of the mirror axis
or
Enter distance<direction coordinates to define the extent of the axis

2nd point of mirror line

Delete source objects? [Yes/No]<n>
Hit enter if you wish to retain the original object (*no* is the default)
or
Type y to erase the original object.

command tips

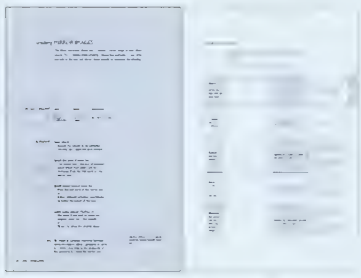
- *additional information for command function*

TIPS To create an accurate clearance between mirrored objects, offset a guideline to serve as a mirror line. Snap to the endpoints of this guideline to create the mirror axis

clearance between mirrored objects is double the distance from the mirror line

85 Lesson 3 Modifying Basics

GUIDED EXERCISES



exercise introduction

- *exercise heading*
- *explanation of exercise*
- *exercise set-up information*
- *image of final outcome*

steps for completing exercise

- *reminder of icon used to initiate command*
- *instruction*
- *screen status*
- *command prompt information*
- *command prompt translation*

practice *mirror*

This exercise will teach you the basic operations in mirroring objects, as well as mirroring objects a precise location from the original object.

Continue with the furniture drawing from the Copy exercise

Zoom: *to see your desk with the desk chair*			*You will utilize both mirror and move to recreate the image above*
Initiate: the mirror command		`Command: _mirror` `Select objects:`	*AutoCAD needs to know what you want to mirror*
Select: the chair (enter)		`Specify first point of mirror line:`	*The mirror line is the axis which is half way between the original object and its mirror image* *Therefore, the first point of the mirror line should be halfway between the original and your intended mirror*
Snap: to the midpoint of the side of the desk		`Specify second point of mirror line:`	*AutoCAD wants to know the endpoint of the line of axis* *The direction of this point is what determines the axis of symmetry*
Observe: the cursor and the resulting mirror image		`Specify second point of mirror line:`	*The direction of the cursor dictates the position of the mirrored image* *The mirror line will always be halfway between the mirrored image and the original object*

85

IN-CLASS SOLO EXERCISES

exercise introduction
- *description of exercise*

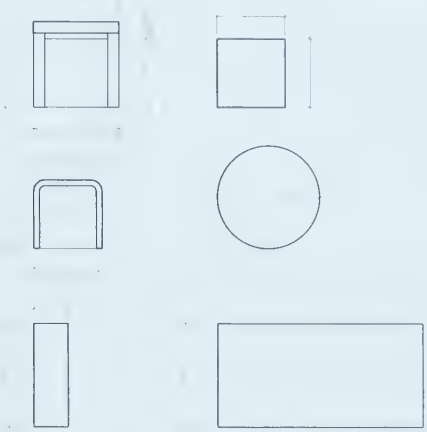
exercise requirements
- *information for completing exercise successfully*

exercise diagrams
- *images and dimensions of drawing to be re-created by students*

warming UP

Loosen up your AutoCAD muscles. Using what you've learned in the last chapter, draw the furniture objects below

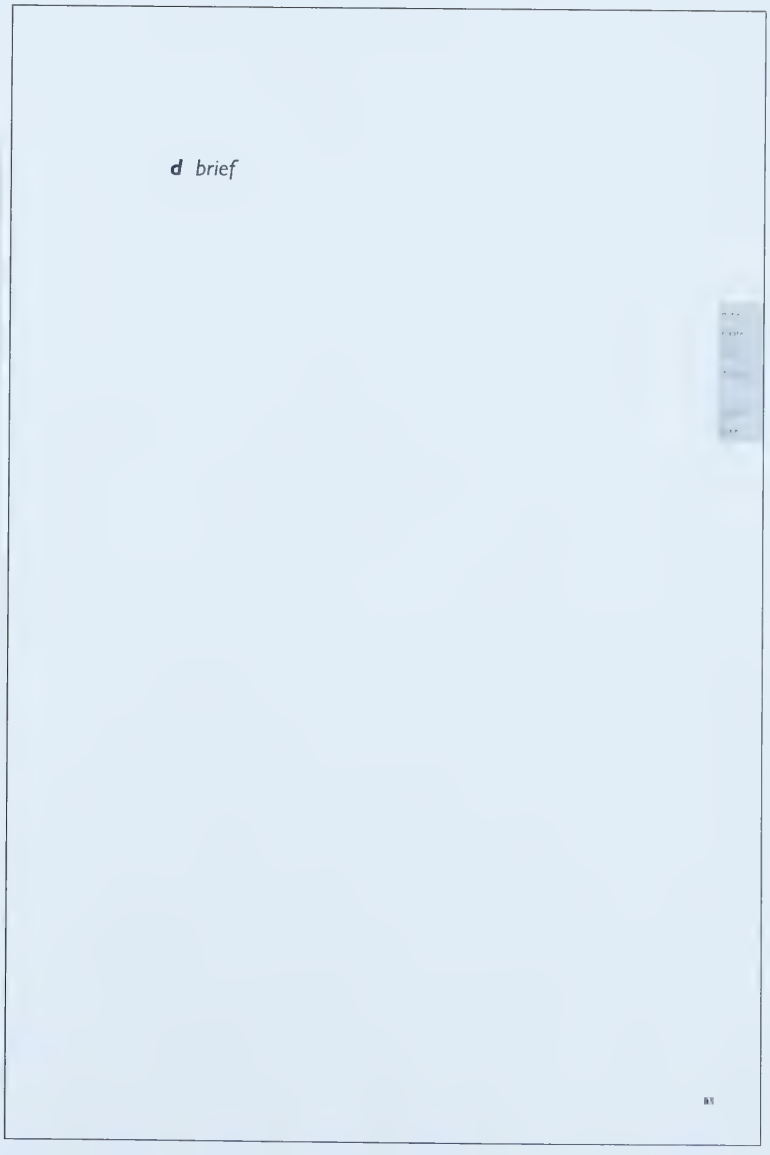
REQUIRED
1. Assess the format and precision of the drawing units.
2. Assess the size required for the drawing limits
3. Assess appropriate grid spacing
4. Start a new drawing.
5. Save as Furniture(student #).dwg
6. Adjust all drafting settings required including Running Osnap



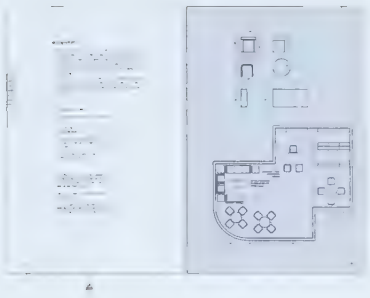
85

NOTE-MAKING

- *heading*
- *blank space for notes and drawings*



SOLO ASSIGNMENTS



assignment introduction
- *description of assignment*

assignment requirements
- *information for completing assignment successfully*

assignment tips
- *information for more efficient drawing methods*

assignment

Now is your chance to put all that modifying know-how to work. Using the shell of the library created on page 83 of lesson 2, draw and locate the furniture arrangement as dimensioned on the opposite page. One minor thing: the library is in imperial units. Therefore, the furniture will have to be re-drawn to suit this format. (Practice makes perfect, that kind of thing...)

Remember: The reason for using AutoCAD is because of its precision. There is no such thing as 'nearly', 'almost', or 'close enough'. Therefore, ensure your furniture is precisely drawn and placed as per the given specifications.

REQUIREMENTS

1. Open Lesson 3.dwg
2. Redraw the furniture using Architectural units
3. Locate the furniture as shown on the opposite page
4. Chairs are to be offset 4" from tables. This includes lounge furniture and the desk.
5. All furniture, including shelves are to be offset 1" from the walls

TIPS

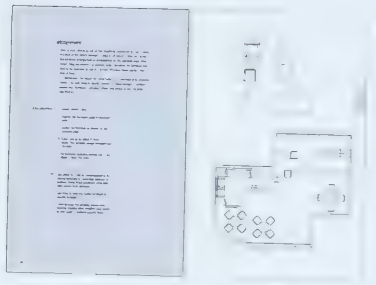
Use offset as a way to create guidelines for placing furniture at a specified distance or location. Erase these guidelines once they have served their purpose.

Use Snap to help you locate furniture to a specific location.

Think through the drawing before commencing. Analyze what modifier tool would be best used to perform specific tasks.

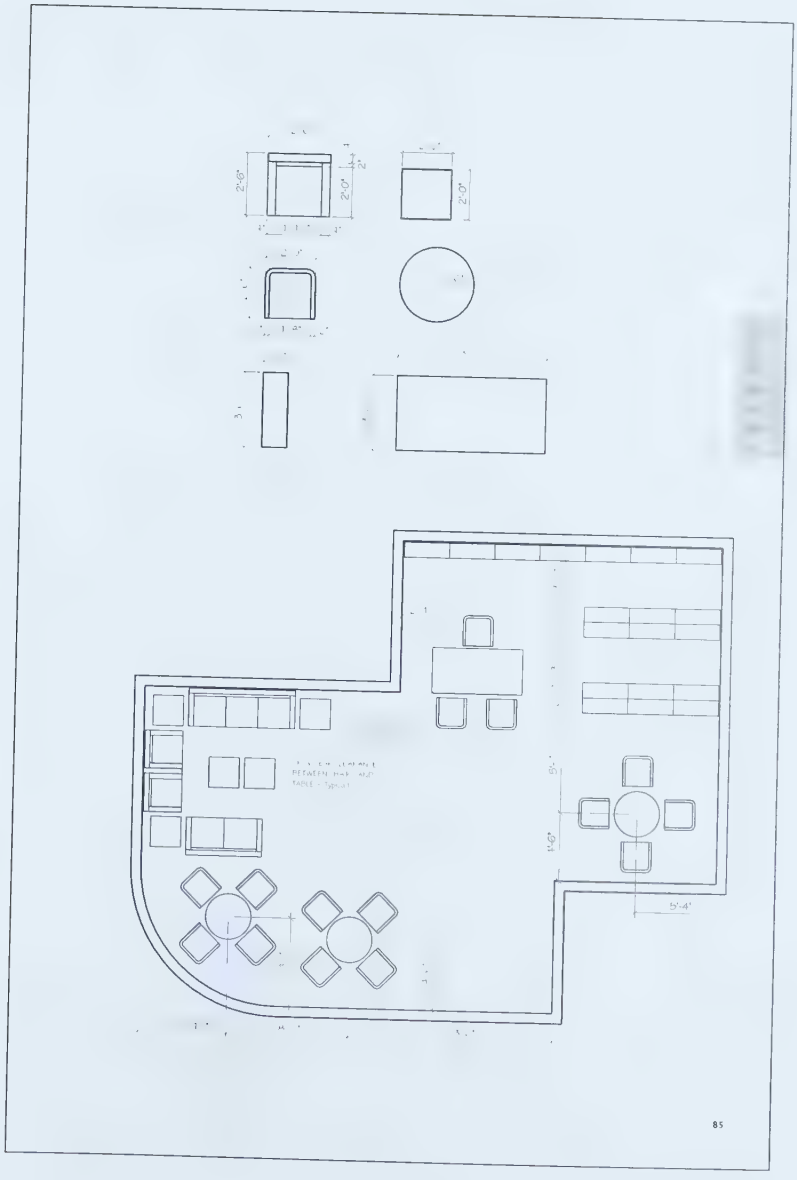
85

SOLO ASSIGNMENTS



assignment diagrams

- *images and dimensions of drawing to be re-created by students*



TYPOGRAPHY
command demonstration

command description
- *heading: 18pt Gill Sans lower case italicized verb with upper case regular noun*
- *body: 10pt / 16pt Gill Sans*

creating MIRROR IMAGES

The *Mirror* command allows you to create a mirror image objects. This is helpful when drawing symmetrical elemen one side of the axis, and mirror those objects to complet

sub-heads
- *10pt upper case Gill Sans (50 letter spacing) with hairline rule above*
- *command prompt titles: 10pt lower case (50 letter spacing)*
- *command prompt clarification: 10pt italicized*

COMMAND PROMPT	icon	menu	command
	modify toolbar	Modify *> mirror*	`mirror`

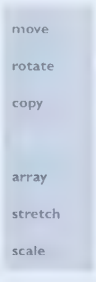
command sub-prompt steps
- *sub-heading: 10pt Gill Sans italicized*
- *text: 10 / 12pt Gill Sans indented 2pt with bold face verbs*

Delete source objects? [Yes/No]<n>:
Hit enter if you wish to retain the original object (*no* is the default).
or
Type y to erase the original object.

captions
- *8pt / 12pt Gill Sans italicized with 70% grey value*

Consider the placement of the mirror line. It should be halfway between the object and the desired clearance from the mirrored object

margin tab
- *8pt / 12pt Gill Sans lower case with active lesson name coloured white*



exercise description
- *heading: 18pt Gill Sans lower case regular verb and italicized noun*
- *body: 10pt / 12pt Gill Sans*

practice *mirror*

This exercise will teach you the basic operations in mirrori objects, as well as mirroring objects a precise location from original object.

instruction
- *10pt Gill Sans (with boldface verb) on either 15% or 30% grey background*

Snap:
to the
midpoint of
the side of
the desk

command sub-prompt
- *10pt Courier typeface on either 15% or 30% grey background*

```
Specify first point of
mirror line:
```

command translation
- *10pt Gill Sans italicized on white background*
- *hairline below each step*

AutoCAD wants to know the endpoint of the line of axis.

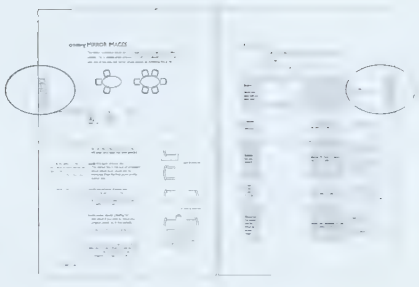
The direction of this point is what determines the axis of symmetry.

NAVIGATION

margin tab

- *list of topics covered in lesson*
- *current topic in white type*
- *grey tab located aligned with lesson location in Table of Contents*

move
rotate
copy
array
stretch
scale

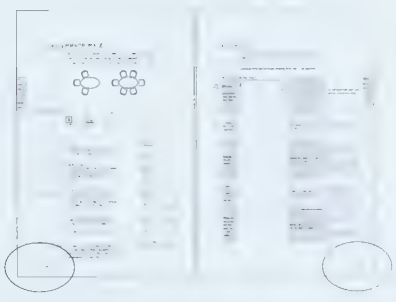


folio

- *page number, lesson number and name on verso*
- *page number on recto*

85 Lesson 3 *Modifying Basics*

85



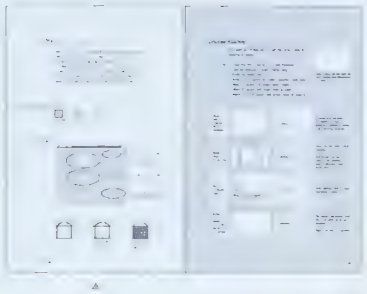
APPENDIX **B**

revised workbook design

LESSON DIVIDERS

- *lesson number*
- *lesson title*
- *image of CAD drawing*
- *vertical banner aligned with lesson location in workbook*

DEMONSTRATION



command introduction

- *command heading*
- *description of command function*
- *images pertaining to command function*

command prompt methods

- *methods for initiating commands*

command sub-prompts steps

- *command sub-prompt requests*
- *responses required*
- *sample diagrams*

adding HATCH PATTERNS

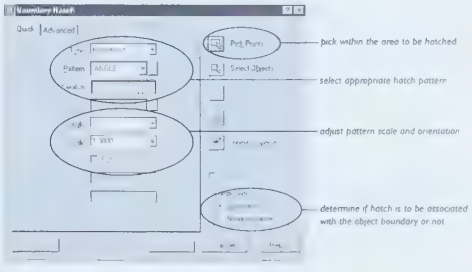
Hatch patterns are very important graphic elements that serve to differentiate one construction material from another — a necessary feature for enhancing drawing readability

Hatch is a fairly easy command to use. All that is required to hatch an object is to select one of the many hatch patterns that AutoCAD offers, adjust the hatch scale and orientation of the pattern, and select the item to be filled with a hatch pattern

COMMAND PROMPT

icon	menu	command
draw toolbar	Draw > hatch	`bhatch`

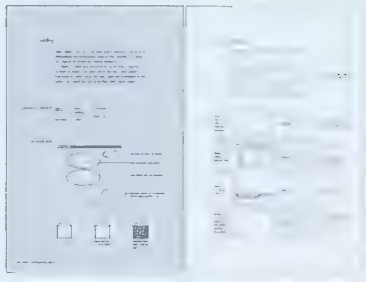
DIALOGUE BOX



Select inside the area to be hatched

Determine hatch pattern, scale and angle

285 Lesson 7 Increasing Drawing Efficiency



exercise introduction

- *exercise heading*
- *explanation of exercise*
- *exercise set-up information in list form*
- *image of final outcome*

steps for completing exercise

- *reminder of icon used to initiate*
- *instruction*
- *screen status*
- *command prompt information*
- *command prompt translation*

practise *hatching*

This exercise will take you through the various steps for hatching an object.

in brief:
1. Open the MRC imperial 11 x 17.dwt (template)
2. Save the template as hatch practice.dwg.
3. Switch to model space.
4. Array a 12 x 12 square to create 4 squares, 3 units apart.
5. Hatch 1st square with 'angle', scale 1, angle 0.
6. Hatch 2nd square with 'angle', scale .25, angle 45.
7. Hatch 3rd and 4th square with 'gravel', scale .25, angle 45

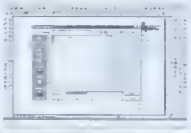
hatch 4 squares with both 'angle' and 'gravel' patterns, using different scales and angles

Open *MRC 11x17 imperial.dwt* drawing template

Command:

As usual, once you open a template, you need to preserve its settings by saving it as a drawing (.dwg) file

Save: *Hatch practice.dwg*

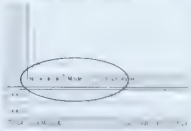


Command:

There! you are ready to begin hatching

First though, you need to switch to the 'drawing board'... otherwise known as model space

Switch: to model space



Command:

That's finished .now you need something to hatch

Draw: a 12 x 12 square in the lower portion of the screen

Command:

The square may appear small due to the limits set for this template

Adjust your view as necessary

285

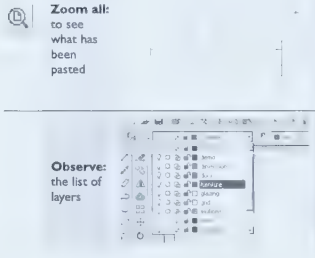
COMMAND TIPS

guided exercise

- *final steps in guided exercise*

tips for using command

- *heading*
- *additional information regarding command not covered in exercise*



***b**|aware*

A similar command to copyclip is 'copybase'. This command allows you to specify a basepoint on the object to be copied.

An item that is pasted into a drawing using copyclip retains its layers. The copied item will also retain and import any text styles and dimension styles created in the original file.

A copyclip item is not registered in a formal library of standards — it is primarily used to quickly copy an item from one file and into another

285

IN-CLASS SOLO EXERCISES

exercise introduction

- *new heading (**c** | what you know)*
- *description of exercise*
- *information for completing exercise successfully*

exercise diagrams

- *images and dimensions of drawing to be re-created by students*

c | *what you know*

The last task remaining to enhance those millwork drawings is to hatch the vertical sections. The details will automatically be hatched, since they are only an elargement of the vertical sections

1. Open Lesson 6.dwg.
2. Ensure the Hatch layer is current.
3. Hatch the counter top, backsplash and base using the 'Lines' hatch pattern at a scale of 1.25. Adust the angle to suit the direction of the construction material.
4. Hatch the door and drawer components using the 'Sand', hatch pattern at a scale of .2.
5. Print your drawings, take a set home and tape them up on your fridge to show everyone how brilliant you are

285

NOTE-MAKING

- *heading*
- *lines for notes*
- *blank space for notes and drawings*

SOLO ASSIGNMENTS

assignment introduction

- *20% grey background*
- *description of assignment*

assignment requirements

- *information for completing assignment successfully*

assignment

Just what you've been waiting for… a chance to snazzify those millwork drawings from Lesson 5 with notes, dimensions, reference keys and labels! Not only will you gain extra practice in dimensioning and adding text to your documents, but by the time you finish this lesson, you will have achieved a nice set of reference details for your final project: The Kitchen!

REQUIREMENTS

1. Open Lesson 5.dwg
2. Save the drawing as Lesson6(student #).dwg
3. Format new layers as required to add text, dimensions, reference keys, and drawing labels.
4. Dimension, annotate, key and label your millwork drawings from Lesson 5. Use the dimensions, notes, and labels on page 209 – 211 as your reference.
5. Complete the labels on each of the the title pages, including sheet numbers.
6. Print the drawings upon completion.
7. Once again, stay tuned for more developments. The next lesson will include hatching the vertical sections.

TYPOGRAPHY
command demonstration

command description
- *heading: 36pt Gill Sans lower case italicized verb raised to align with upper case command name (70% grey)*
- *body: 11pt/16pt Gill Sans*

adding HATCH PATTERNS

Hatch patterns are very important graphic elements differentiate one construction material from anothe sary feature for enhancing drawing readability.

sub-heads
- *10pt upper case Gill Sans (50 letter spacing) with hairline rule above*
- *command prompt titles: 10pt Gill Sans boldface lower case (50 letter spacing)*
- *command prompt clarification: 10pt italicized*

COMMAND PROMPT **icon** **menu**

dimension toolbar

Dimension

> dimlinear

command sub-prompt steps
- *sub-heading: 11pt/13pt Gill Sans italicized*
- *text: 11/13pt Gill Sans indented 2pt with bold face verbs indicating main action required*

Specify first extension line origin or <select object>:

Pick one end of the line to be dimensioned.
Use Osnap for precision.
or
Hit enter, and select the line to be dimensioned

exercise description
- *heading: 18pt Gill Sans lower case regular verb and italicized command name*
- *body: 10pt / 12pt Gill Sans*
- *exercise objectives formatted as a numerical list*

practise *hatching*

This exercise will take you through the various steps for hatching an object.

in brief:
1. Open the MRC imperial 11 x 17.dwt (template).
2. Save the template as hatch practice.dwg.
3. Switch to model space.

instruction
- *11pt Gill Sans (with boldface verb) on either 10% or 20% grey background*

Switch:
to model space

command sub-prompt
- *10pt Courier bold typeface on either 10% or 20% grey background*

```
Command:
```

command translation
- *11pt Gill Sans italicized on white background*

The square may appear small due to the limits set for this template.

Adjust your view as necessary.

APPENDIX C

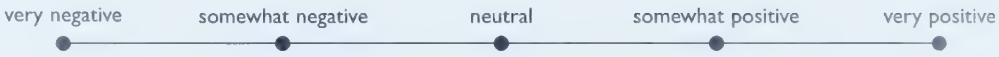
survey questionnaires

learner profile

part I

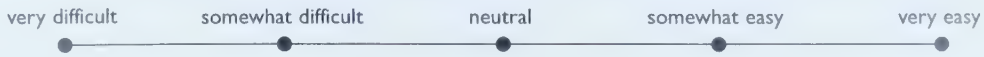
before you launch on your autocad journey.... your intrepid researcher needs to know a couple of things about you.

How are you feeling about learning AutoCAD?



Do you wish to elaborate?

What are your preconceived ideas about AutoCAD computer drafting software?



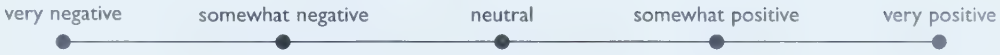
Do you wish to elaborate?

learner profile

part 2

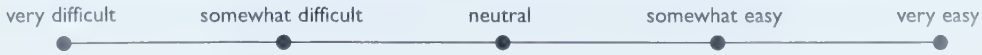
now that you've had a taste of your autocad lesson, how would you respond to the same questions you answered earlier?

How are you feeling about learning AutoCAD?



Do you wish to elaborate?

What are your preconceived ideas about AutoCAD computer drafting software?



Do you wish to elaborate?

learner profile

part 3

here are some very important demographic questions to help me get a better understanding of the learners enrolled in this course. Please circle the category which applies to you.

Age:

18-22 22-25 26-30 31-35 36-40 41-45 46-50 51-55 56+

Gender:

female male

Highest level of education prior to enrolling in the Interior Design Program

High-school diploma Some post-secondary Post-secondary diploma Post-secondary degree

What is your level of general computer proficiency?

beginner advanced beginner intermediate advanced expert

learner profile

part 4

the rest of these questions will help me develop an inventory of the type of learners enrolled in this class. Rank each learning style according to the number system below:

4 = most like you
3 = second most like you
2 = third most like you
1 = least like you

A sample question would be answered in the following manner:

A. When I learn:

_____ I am happy _____ I am fast _____ I am logical _____ I am careful

---

1. When I learn:

_____ I like to deal with my feelings. _____ I like to think about ideas. _____ I like to be doing things. _____ I like to watch and listen.

2. I learn best when:

_____ I listen and watch carefully. _____ I rely on logical thinking. _____ I trust my hunches and feelings. _____ I work hard to get things done.

3. When I am learning:

_____ I tend to reason things out. _____ I am responsible about things. _____ I am quiet and reserved. _____ I have strong feelings and reactions.

4. I learn by:

_____ feeling. _____ doing. _____ watching. _____ thinking.

Experience-based Learning Systems, Inc., Developed by David A. Kolb

Ellis, Dave (2000) Becoming a Master Student. *New York: Houghton Mifflin Company*

5. When I learn:

_____ I am open to new experiences
_____ I look at all sides of issues.
_____ I like to analyze things, break them down into their parts.
_____ I like to try things out.

6. When I am learning:

_____ I am an observing person.
_____ I am an active person.
_____ I am an intuitive person.
_____ I am a logical person.

7. I learn best from:

_____ observation.
_____ personal relationships.
_____ rational theories.
_____ a chance to try out and practice.

8. When I learn:

_____ I like to see results from my work.
_____ I like ideas and theories.
_____ I take my time before acting.
_____ I feel personally involved in things.

9. I learn best when:

_____ I rely on my observations
_____ I rely on my feelings.
_____ I can try things out for myself.
_____ I rely on my ideas.

10. When I am learning:

_____ I am a reserved person.
_____ I am an accepting person.
_____ I am a responsible person.
_____ I am a rational person.

11. When I learn:

_____ I get involved.
_____ I like to observe.
_____ I evaluate things.
_____ I like to be active.

12. I learn best when:

_____ I analyze ideas.
_____ I am receptive and open-minded.
_____ I am careful.
_____ I am practical.

research participation

The intent of this research is to design and develop instructional materials that enhance student understanding and promote independent learning of AutoCAD software.

But I need your help. Would you be willing to:

yes no Become part of the design committee?

• This would involve participating in focus group meetings to provide feedback on the design and content of the AutoCAD workbook. There will be a total of 4 meetings throughout the semester, each lasting between 1 - 2 hours.

• Discussion would center around the effectiveness and functionality of the course materials and how they could be improved for future interior design students.

• Participation would be voluntary, all comments would remain confidential, and participants would be free to withdraw at anytime.

yes no Respond to survey questionnaires?

• As the semester progresses, approximately 4 questionnaires will be administered to determine learner satisfaction with course materials.

• Time will be alotted in class to respond to these questionnaires, and should not take more than 15 minutes to complete.

• Participation would be voluntary, all comments would remain confidential, and participants would be free to withdraw at anytime.

If you have agreed to participate in the testing of the instructional materials, please leave me your email address so that I may contact you regarding your participation.

MRC email: _____

Much appreciated!

workbook design

integrity | function | delight

This is the first of three questionnaires pertaining to the design of the AutoCAD workbook.

This questionnaire addresses the *integrity* or format of the workbook. Your responses will help me determine the degree of success of things such as workbook size, page layout, typeface character, and navigational devices. This will have an impact on the design of the final lessons.

The remaining 2 questionnaires will deal with the content of the workbook (function) and the style of the workbook (delight). These will be administered in the middle and at the end of the semester.

Once again, I greatly appreciate your efforts in helping me to create a useful autocad workbook for future interior design generations!

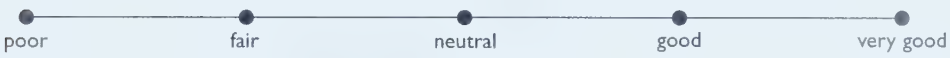
workbook format

structure this portion of the survey deals with your level of satisfaction regarding how the book has been assembled: its size, manoeuvrability, and durability.

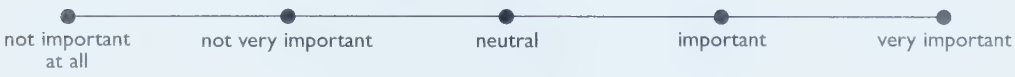
As you answer these questions, think of basic ergonomic issues: how you use the book while at the computer, how it fits into your school bag, how it feels to carry it along with your other books.

proportion **1.** The proportion of the book (8 x 12, vertical format) has been designed to efficiently accommodate the amount and type of information in the workbook as well as to acknowledge the limited work surface available when working at a computer.

How would you rate the 8 x 12 vertical proportion of the workbook

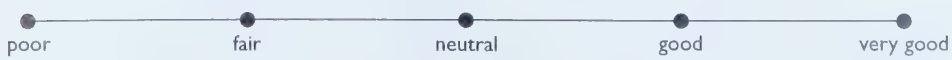


How important is this to you?

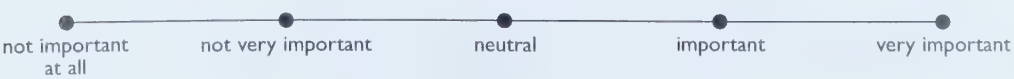


binding **2.** The coil binding was selected for its durability, flexibility, and to help keep the costs of the workbook to a minimum.

How would you rate the coil binding used in the workbook



How important is the method of binding to you?



durability **3.** The quality of paper chosen for this workbook was balanced with the need to keep costs to a minimum. This impacts how well the workbook will stand up to every day use and the quality and resolution of the printing.

How would you rate the durability of the workbook.

How important is this to you?

comments, suggestions, critiques?

clarity

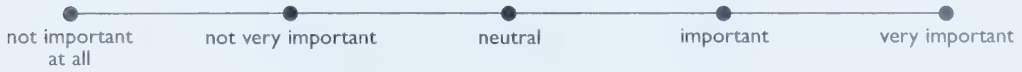
this portion of the survey deals with your level of satisfaction regarding the readability of the text and diagrams.

typeface

4. The typeface (Gill Sans MT) was chosen both for its clarity, and its clean, 'architectural', character. The body text size (10pt) was selected to maximize the amount of information on a page while maintaining readability.

How conducive is the typeface for reading and understanding the information?

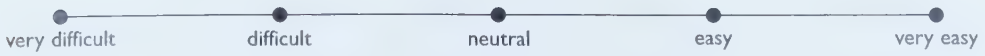
How important is this to you?



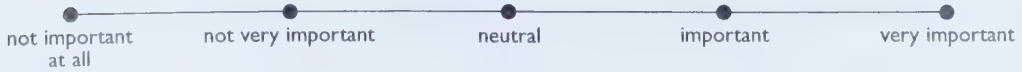
information hierarchy

5. Different sizes of typefaces have been assigned to different 'levels' of information to clarify major headings, subheadings, body text, and labels.

How easy is it to interpret the level of importance assigned to the different types of information?



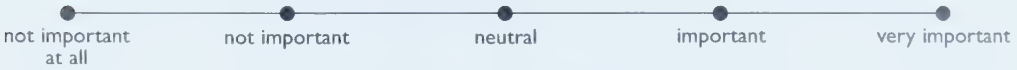
How important is this to you?



graphics **6.** The intent of the graphics is to provide a demonstration of how the commands work.

How would you rate the graphics (line drawings and screen captures) for helping you comprehend the written information?

How important is this to you?



comments, suggestions, critiques?

layout this portion of the survey will demonstrate to me how well the document has been layed out such that it is predictable and clear.

Without referring back to the workbook, give your best guess as to where the typical location of the different types of information.

***Circle** the general area to show where, on a typical two-page spread, you would normally find the following information.*

A sample question would be answered as followed:

Locate where you would find the page numbers.

How often do you refer to this?

never — sometimes — neutral — often — always

Okay. Now it's your turn:

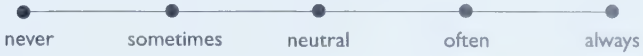
7. Where would you find the introduction to the command and its basic description?

How often do you refer to this?

never — sometimes — neutral — often — always

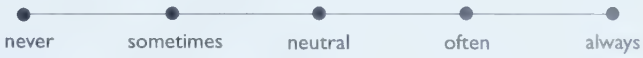
8. Where would you find the different ways (icon, menu, typing) to launch a command?

How often do you refer to this?



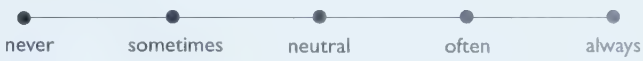
9. Where would you find the description of the steps (sub-prompts) required to complete a command?

How often do you refer to this?



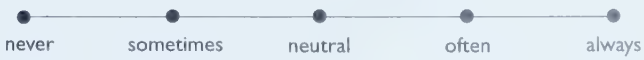
10. Where would you find tips for using a command with more efficiency?

How often do you refer to this?



11. Where would you find the diagrams which explain how a command works?

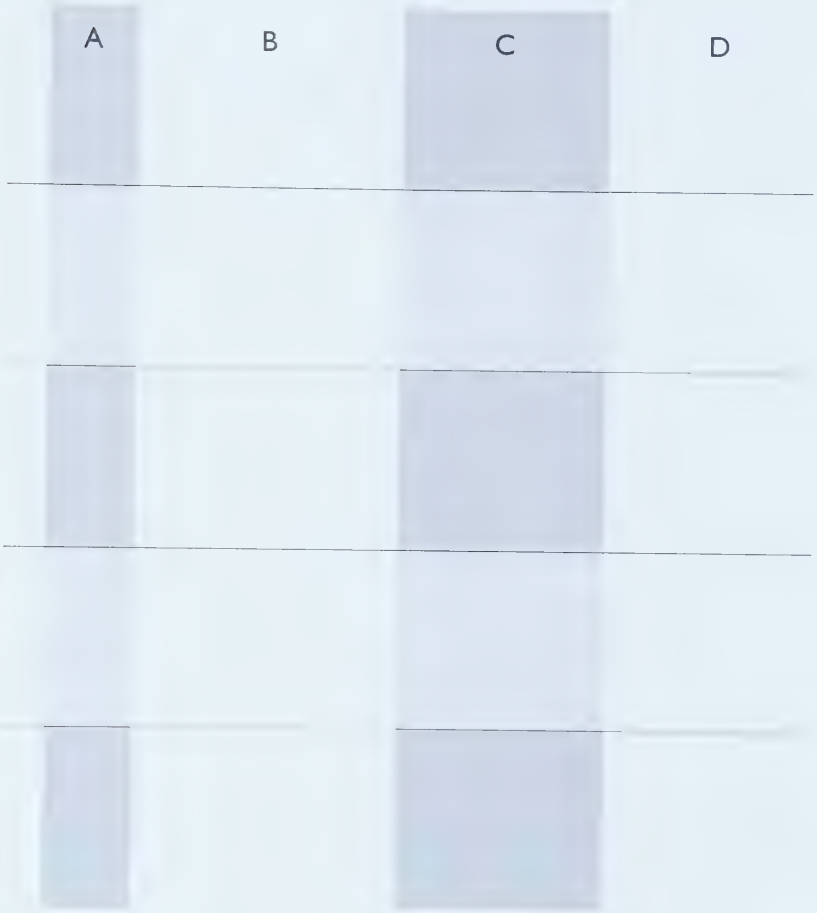
How often do you refer to this?



12. Where would you find how to set up the drawing to begin a practice exercise?

How often do you refer to this?

13. The practice exercises are organized as shown below. Do your best to describe the type of information devoted to each of the columns A B C and D.



A _____

B _____

C _____

D _____

14. How helpful is the above layout for doing practice exercises?

not helpful at all — not helpful — neutral — helpful — very helpful

15. How important is predictability of the workbook layout to you?

not important at all — not important — neutral — important — very important

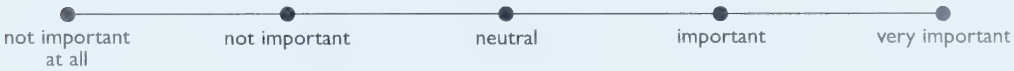
comments, suggestions, critiques?

navigation

this portion of the survey deals with your level of satisfaction regarding the way in which you find specific information in the workbook.

16. How easy is it to find specific information in the book?

How important is this to you?



tour

lines

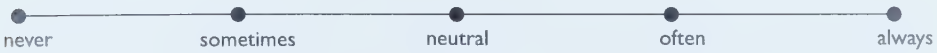
erase

precision

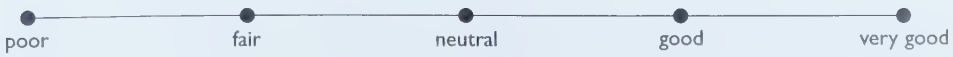
osnap

saving files

17. How often do you use this navigational device to help you determine your location in the workbook?



How well do you think it works?



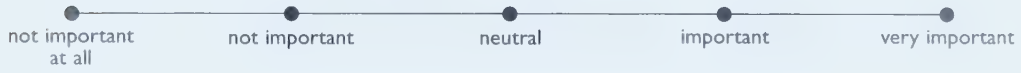
comments, suggestions, critiques?

miscellaneous

these final questions deal with other issues which impact the overall format of the workbook.

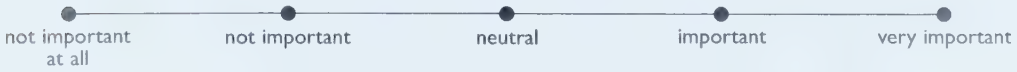
18. How often do you use the workbook to make notes?

How important is this to you?



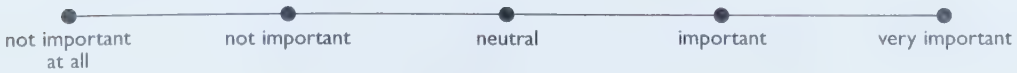
19. What would be the maximum limit you would spend on a computer manual?

How important is the cost of the workbook to you?



20. Finally, how would you grade the overall format of the workbook?

How important is this to you?



Generally speaking, what works? What needs improving?

workbook
design

integrity | function | delight

This is the second of three questionnaires pertaining to the design of the AutoCAD workbook.

This questionnaire addresses the function of the workbook — in other words, did the workbook actually help you to learn AutoCAD?

As you complete the survey, keep in mind the main goals which drove the structure and content of the workbook curriculum

- to teach you how to create a set of architectural drawings using AutoCAD
- to encourage you to take risks, and eventually develop the ability to 'learn how to learn'
- to make learning AutoCAD enjoyable and uncomplicated.
- to satisfy a variety of learners, from those who prefer learning through teacher guidance, to those who prefer to learn independently.

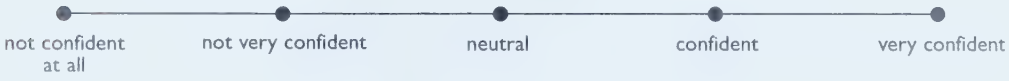
I greatly appreciate your efforts in helping me to create a useful autocad workbook for future interior design students!

workbook curriculum

efficacy

Essentially, how well did the AutoCAD workbook serve its intent of teaching you how to use AutoCAD? Keep in mind that the course content focused primarily on teaching the features that are necessary for creating architectural drawings.

1. How would you rank your confidence level with using AutoCAD?

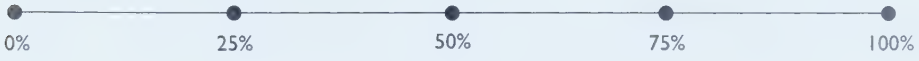


could you elaborate on that?

2. How useful has the workbook been for learning how to use AutoCAD?

comments?

3. What percentage value would you attribute to the workbook for your skill development in AutoCAD?



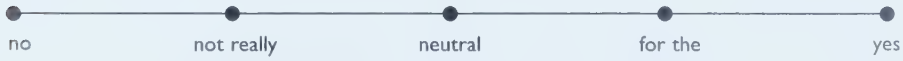
comments, suggestions, critique?

4. Do you think there is anything that should be added or reinforced in the workbook to promote a better understanding of AutoCAD?

content and organization

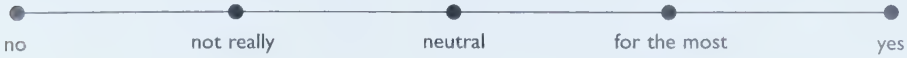
These questions pertain to the topics included in the workbook and how they have been sequenced.

5. Do you feel that the amount of material included in the workbook was adequate to learn how to create a set of architectural drawings?



could you elaborate on that?

6. Was the curriculum organized in a fashion that was logical and easy to follow?

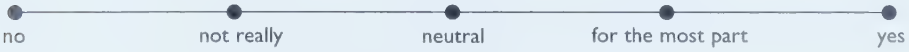


comments? suggestions? critiques?

7. Was the curriculum presented in manageable amounts?

comments, suggestions, critique?

8. Was the curriculum presented in such a way that kept you challenged but not overwhelmed?



could you elaborate on that?

learning styles

the following questions relate to the various learning styles of students enrolled in the AutoCAD course.

Rank the following sentences by assigning the most appropriate value. The value for each number is as follows:

1 = most applicable to me
2 = 2nd most applicable to me
3 = third most applicable to me
4 = least applicable to me

9. I seemed to learn AutoCAD best by:

_____ engaging in dialogue, listening and sharing ideas

_____ listening closely to instruction

_____ problem-solving, and tinkering until I got things right

_____ trusting my intuition and taking chances

10. The thing that contributed the most to my understanding of AutoCAD was:

_____ the step by step practice exercises in the workbook

_____ instructor input through lecture, personal assistance, and assignment critique

_____ the solo assignments (sofa, plan and elevation of a chair, the library, the office, millwork drawings, etc.)

_____ working things through with classmates

11. If I ran into trouble doing one of the step-by-step practice exercises, I recovered most often by:

_____ re-reading and working back through the exercise

_____ going on to the next exercise

_____ consulting an instructor or classmate

_____ experimenting until I got it right

12. If I ran into trouble doing an assignment, I recovered most often by:

_____ referring back to the workbook

_____ going on to something else

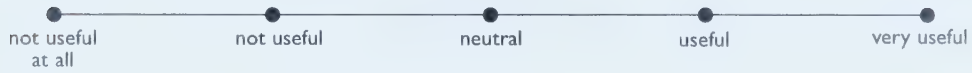
_____ consulting an instructor or classmate

_____ experimenting until I got it right

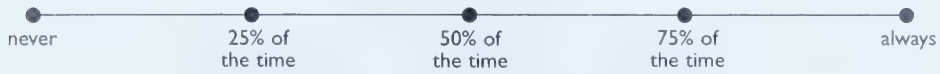
step-by-step exercises

these questions deal with the practice exercises and how well they contributed to building your understanding of AutoCAD.

13. How useful were the step-by-step practice exercises for helping you understand how AutoCAD commands work?



14. How often did you complete the practice exercises?



15. How could the step-by-step practice exercises be improved?

assignments

these questions deal with the assignments and how well they contributed to building your skills in AutoCAD.

16. Did you find the assignments relevant and useful for developing your understanding of AutoCAD?

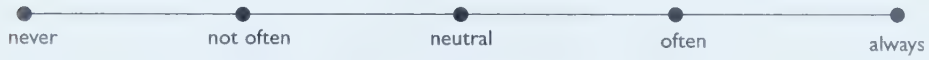
care to elaborate?

17. How would you modify any of the assignments to encourage a better understanding of AutoCAD? (Should anything be added or deleted?)

independent learning

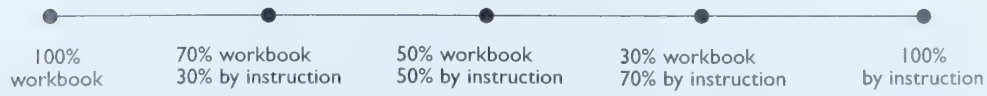
these questions relate to how confident you are using the workbook as a tool to teach yourself how to use AutoCAD.

18. Did you ever use the workbook to either catch up or work ahead?



could you elaborate on that?

19. Circle the percentage value which best indicates how you learned to use the AutoCAD software



could you elaborate on that?

20. In addition to spending $50.00 on the workbook, would you be willing to spend another $250.00 to purchase AutoCAD software?

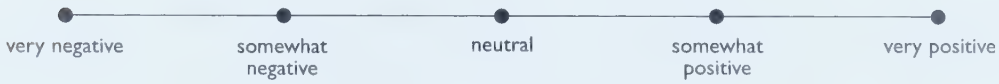
☐ YES

☐ NO

21. What would be needed in the AutoCAD curriculum in order to run a successful independent learning option?

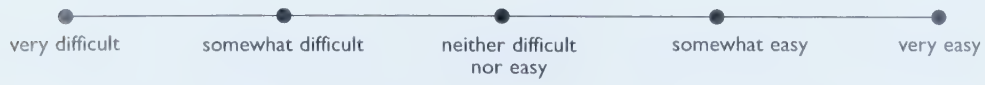
general issues at the beginning of classes, you provided information about your attitude toward learning AutoCAD, and the level of difficulty involved. Has your attitude changed now that you have completed the course?

22. Now that you have experienced 12 weeks of AutoCAD instruction, what is your attitude toward learning AutoCAD?



care to elaborate on that?

23. What has it been like for you to learn the AutoCAD software?



could you elaborate on that?

21. Feel free to add anything else you think would contribute to the success of this workbook as a learning tool for AutoCAD

APPENDIX **D**

survey results

LEARNER DEMOGRAPHICS

	age						gender		prior education				perceived computer proficiency				
	1	2	3	4	5	6	F	M	1	2	3	4	1	2	3	4	5
1		•					•				•				•		
2		•					•			•					•		
3	•						•		•					•			
4			•				•					•			•		
5	•						•		•						•		
6		•					•			•				•			
7			•				•				•					•	
8	•							•		•						•	
9		•					•			•						•	
10	•						•		•					•			
11		•					•			•					•		
12	•						•		•						•		
13		•						•		•			•				
14		•					•			•						•	
15		•						•			•				•		
16	•						•		•							•	
17		•					•				•			•			
18						•	•					•			•		
19	•						•		•						•		
20				•			•					•				•	
21	•						•			•					•		
22		•					•					•			•		
23			•					•				•			•		
24					•		•					•	•				
25		•					•					•		•			
26		•					•			•					•		
27		•					•					•			•		
28				•			•			•					•		
29				•			•			•				•			
30	•						•		•						•		
31			•				•			•				•			
32	•						•			•					•		
total	10	13	4	3	1	1	28	4	7	13	4	8	2	7	17	6	0
rall rank	23 yrs						87%	13%	22%	40%	13%	25%	2.84				

age ranking

1 = 18 - 22 years

2 = 22 - 25 years

3 = 26 - 30 years

4 = 31 - 35 years

5 = 36 - 40 years

6 = 41 - 45 years

education ranking

1 = high school

2 = some post-secondary

3 = post-secondary diploma

4 = post-secondary degree

computer proficiency ranking

1 = beginner

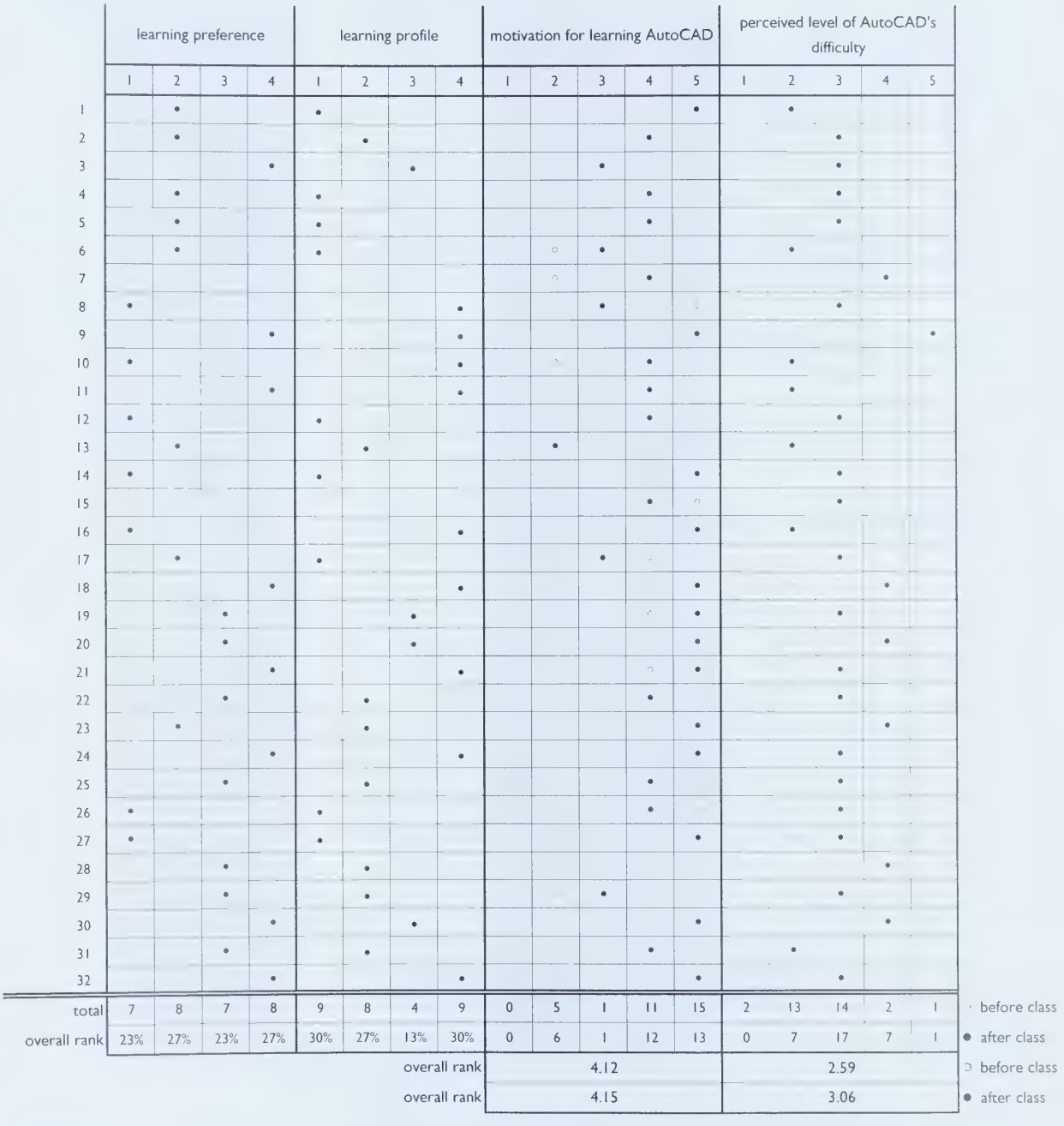
2 = advanced beginner

3 = intermediate

4 = advanced

5 = expert

LEARNER PROFILE



preference ranking

1 = concrete experiences

2 = reflective observation

3 = abstract concepts

4 = active experimentation

profile ranking

1 = divergent

2 = assimilating

3 = convergent

4 = accommodating

attitude ranking

1 = very negative

2 = negative

3 = neutral

4 = postive

5 = very positive

difficulty ranking

1 = very difficult

2 = difficult

3 = neutral

4 = easy

5 = very easy

LEARNER ATTITUDE
qualitative responses

attitudes toward learning AutoCAD **prior** to the first class are indicated in **regular** type

attitudes toward learning AutoCAD ***after*** *the first class are indicated in* ***italicized*** *type*

How are you feeling about learning AutoCAD?

I am excited to learn something new!

I am intimidated by it but I know it will prove to be a useful tool. *There is a lot of logical sequence and it's something we just have to get used to.*

I have taken an autocad course from a computer geek which was tough. Looking forward to taking it from people focussed on int. des. *Manual seems very helpful.*

I'm excited about the class, I've always enjoyed computers so I see it as a new avenue for something I enjoy. *Still excited, looking forward to doing more.*

I've never really enjoyed computers. I get frustrated easily using the computer. If I don't have to use one, then I won't. *It doesn't seem as bad as I thought*

Intimidated.

Excited to have the opportunity to learn something completely new. *Quite repetitive.*

I have taken a few courses on AutoCAD and also Visual Cad. *Because I haven't touched it for a year I am getting reacquainted with the program.*

I don't get along with computers very well, they just don't seem to do what I want them to. *I find it much easer to do, and feel quite relaxed because the book guides you along step by step.*

Want to learn, a little scared. *It is at a pace I can handle, teacher's very excited, this attitude really helps.*

It will be a great break from the hand drafting in other courses.

I have very little computer training and am feeling quite intimidated about learning AutoCAD. *I'm finding that there is a lot to know and understand. I will take a while to get a grasp on it.*

I'm looking forward to seeing my ideas come together more quickly.

It should speed up drafting and allow for changes; opposed to manual. *Should cut work in half; more convenient than manual to edit.*

I have taken 2 years of AutoCAD in high school, however I've forgotten lots and don't know AutoCAD 2000. *As I have taken it before, I am fairly confident this will be more of a 'refresher' course.*

I'm excited, but also a little scared to learn AutoCAD. I guess that's why I'm only somewhat positive—but that's what makes learning interesting. *A little confusing—only because I'm a slow learner. But it will all be ok. It's really not that scary with your book.*

I can't wait—I want to learn it, and be proficient by the end of April so that I am ready to work. *So far, so good. Step by step, easy. Full steam ahead.*

What others have said about AutoCAD I feel positive about it because everyone has said it is so much faster. *Now that we have gone through the start of the manual, I feel more confident knowing that there are steps to follow and refer back to.*

It's a practical skill to know.

I have hand drafted for some years and hearing what my family members have to say about Autocad (They all work with Autocad) it sounds exciting.

I know that learning this is important to my future career and employment success. It always helps to be positive when learning new skills.

I think it will alleviate many laborious hours. *Somewhat positive.We've barely scratched the surface.*

I know how important this is in the industry and everyone talks about it. I would feel privileged to know and have the ability to use autocad; it's the next step in this program and I'm looking forward to it. I'm also a bit nervous because it's a new program and a very big program. *The basic commands that we have just dealt with don't seem too difficult, but it's hard to get them straight in my mind. I feel good about it all, I just know that getting it all straight will take time.*

I'm very excited about learning AutoCAD but I'm a little 'scared'. It should be fun and interesting. So far, so good. If we take it step by step this should be a good time. I can handle this.

I love working with computers. In fact I think I'll prefer it over hand drafting. *I want to speed up the learning process so I can learn more!*

I am really fearful. I have a small child so my time is very limited. In past experiences something has gone wrong using a computer causing a serious drain on my time. *Instructor positive, workbook provides step by step.*

I don't have a lot of experience with AutoCAD or computers in general and I am very excited to learn more.

It is a challenge to learn something new and I can be frustrated because it is a slow process but I look forward to having this skill.

I have worked a little with autocad, really enjoyed the experience.

What are your preconceived ideas about AutoCAD computer drafting software?

I have different opinions after receiving info. I think it will take time to fully understand.

I don't know the extent of what it can do but I am interested.

Setting up the documents was a huge challenge for me. Other aspects easy to learn.

I really don't know what to expect, I imagine it will be challenging, but hopefully enjoyable. *Still the same, although it appears easy to start. I'm sure it will become more difficult.*

I have a feeling it will be hard, I'm really nervous about it. *I'm sure it's going to get harder.*

It looks too complicated.

It is apparently difficult —but nothing to be frightened of.

I find it very easy and enjoyable yet time consuming. *I will be glad when we are able to work at our own pace.*

Took a class at SAIT and I found it really hard to grasp. *Still have a long way to go.*

I am just more aware of how much I don't know!

Because I have little computer experience I think that computer drafting will be somewhat overwhelming. *There is a lot to know, but following the manual makes it 'less scary'.*

perceptions regarding AutoCAD's level of difficulty **prior** to the first class are indicated in **regular** type

*perceptions regarding AutoCAD's level of difficulty **after** the first class are indicated in **italicized** type*

I'm not sure yet how well I will learn this.

It should speed up drafting and allow for changes; opposed to manual. *Some past experience, but need to be refreshed.*

Difficult to learn, but easy to use after. *It took me a long time to learn AutoCAD in high school, as it did most of the girls in my class. The male students, however, found it easier—as it was fairly self-taught. I think this manual's a great idea and asset.*

No one ever told me anything about AutoCAD. All I know is that we use it for computer drafting.

I am happy to get away from hand drafting.

It takes a little finesse and the knowledge to manoeuvre around the keyboard, the program and keep the end result complete. *Easy commands, multiple ways to access.*

The idea of technology and AutoCAD is a little scary because I have heard of horror stories of a major breakdowns.

I heard it is not a very intuitive program to use. *It just seems to take practice and quick commands need to be memorized. One mistake made me panic briefly, but at this stage it is to be expected since one doesn't know what one has pressed nor how to fix the problem.*

I don't really know anything about it. I am nervous about it of course too because I want to do well.

I don't know too much about the program. *Neutral, we're not very far yet, so far it seems pretty manageable.*

I've heard various people about the extensiveness of the software. I know it's very detailed and I have the impression that it's more difficult than I think. *It seems very approachable and learnable right now, not at all difficult. But, I know we'll be introduced to more, so time will tell.*

I have no idea! I have no knowledge of this program, but I think it'll be a challenge. *This doesn't seem too bad, I should be able to make it through.*

I think once the techniques are learned it will be fairly easy to use. *It seems easier than I thought it would be so far, but this is just the beginning. I'm sure it gets harder.*

I am not familiar with the program so I have no preconceived ideas. *Many little details to know.*

Because I have a lack of experience with computers I may have a bit of trouble getting started. However I learn quickly and the workbook seems very straight forward.

I have never even looked at anything to do with autocad so I'm sure it will be difficult. Also I'm not very confident or experienced with computers in general.

I know some basic knowledge about autocad, I still find some areas a challenge.

What are your first impressions regarding the workbook?

It looks like someone should be telling us we are very lucky to be a part of this project. Of course I'm intimidated but I think I have a better attitude than that. The workbook looks well layed out and I know it will be good to learn.

Looks great. Very helpful having pictures of what you will see on the screen. Tips—great idea to give useful info like these.

From briefly looking at the book, it appears very informative. The way it is set up will be very helpful due to the fact it shows you step by step how to do things.

I think the workbook is a great idea. I'm sure its going to be very useful and it appears less intimidating than other books on AutoCAD.

Design oriented, visual learner (based), seems a bit repetitive, not intimidating, no quick reference, love the coil binding!

Some of the pictures are hard to read e.g.. Pg. 44 and 45, the front and back cover will be easily torn because they are larger than the inside pages, in the series pictures on page 72 maybe you could highlight the part you are working on with a darker line.

My first impressions of the book are that it looks really helpful. It also looks really detailed. From what I can tell it looks like it helps you through every step of each thing. I t doesn't seem to jump around, but rather it guides you through the process.

Having looked through an AutoCAD book before I would say this is less daunting. Laid out well. But full of things which at the moment don't make a lot of sense. I like the tabs in the top corner of the page.

Much smaller than I was expecting! Thorough, looks clear and appears to have good instructions (or something I can understand). Makes me feel a little more intimidated by AutoCAD—only because it proves how little I know coming into the class. Like the design of the cover. Really like how it has the 'practice' sections and 'drawing' sections.

Text seems very comprehensive and thorough.

This book seems like it will make life this semester much easier! Good format, looks easy to follow.

It appears to be a successful cohesion of instructions geared especially towards us. I enjoy pictorials within instructions and this has 'em plenty.

The workbook is larger than I would have anticipated. This appears to be very thorough and instructional, as compared to any AutoCAD booklet I have been given by any drafting instructors previously.

Wow. I never new that before this, there was not step by step guide to learning autocad for designers. Thank you for making things easier for us.

It looks cool! Looks comprehensive, well-set up, thorough, user-friendly.

Looks like a construction/computer book. Lots of pictures, I like that as I find it hard to read this kind of material without pictures.

Coil: very good. Weight: not too heavy, very good. Great cover graphics: autocad, dynamic, title bar—'label ability' keep straight who's who. I like size and shape format. Good grid: text structure, complex/dynamic. Good use of different fonts. I would suggest a back cover in a similar gloss perhaps, also full colour.

Professional. Straightforward.

Nice layout. Plenty of diagrams. Text is not packed together but nicely grouped with related images. Cover too flimsy; if I put it in and out of my back repeatedly the cover will rip off (from previous experience of such books).

Great cover. I could see the cover being torn off cold it be some sort of poly material. On each page at the right side a 1½ inch note block would be great.

Manual appears to be thorough and professional. Cover needs to be made of stronger paper.

The workbook appears to be organized in a way in which seems appropriate to learning. I'm sure there is more than this book to learn but this looks like a great place to start.

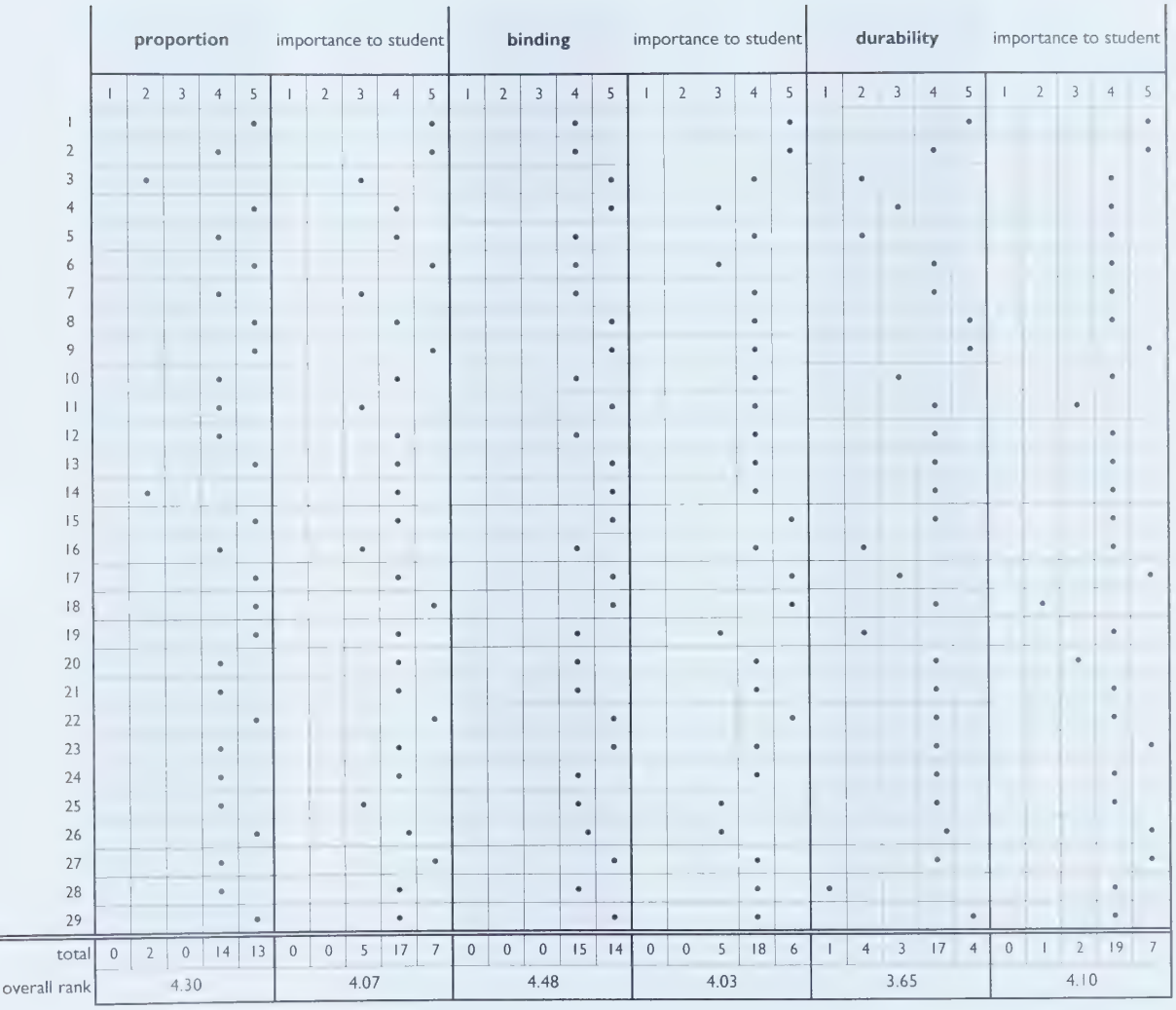
Looks professional. Very big, lots of information.

Wow! Looks like good basics to build on. Very impressive.

Professional. Authentic.

Dramatic line. Colour bland.

WORKBOOK STRUCTURE



quality ranking	*importance ranking*
1 = poor	1 = not important at all
2 = fair	2 = not important
3 = neutral	3 = neutral
4 = good	4 = important
5 = very good	5 = very important

WORKBOOK STRUCTURE
qualitative responses

I would like the cover or binding to be strong enough so that the workbook would support itself on the desk beside me while working on the computer.

A more durable cover, even with a case to place a zip or floppy disk. Would it be possible to have a binder format? I love tabs this way it is easy to refer to different sections and assignment.

8.5 x 11 standard, fits into standard binder. Heavier weight paper, durability especially cover.

The cover has to be stronger. I can see the cover tattering easily. I like the paper it is printed on. I like the way the book is binded makes it easier to use in class.

Cover page and back page are the problem. I believe it would be more durable with a plastic/laminated back cover sheet.

The size of the cover should be the same size as the rest of the book if it is a soft cover. The cover is easily ripped and doesn't protect the inner pages. 3 holes for binders would be nicer.

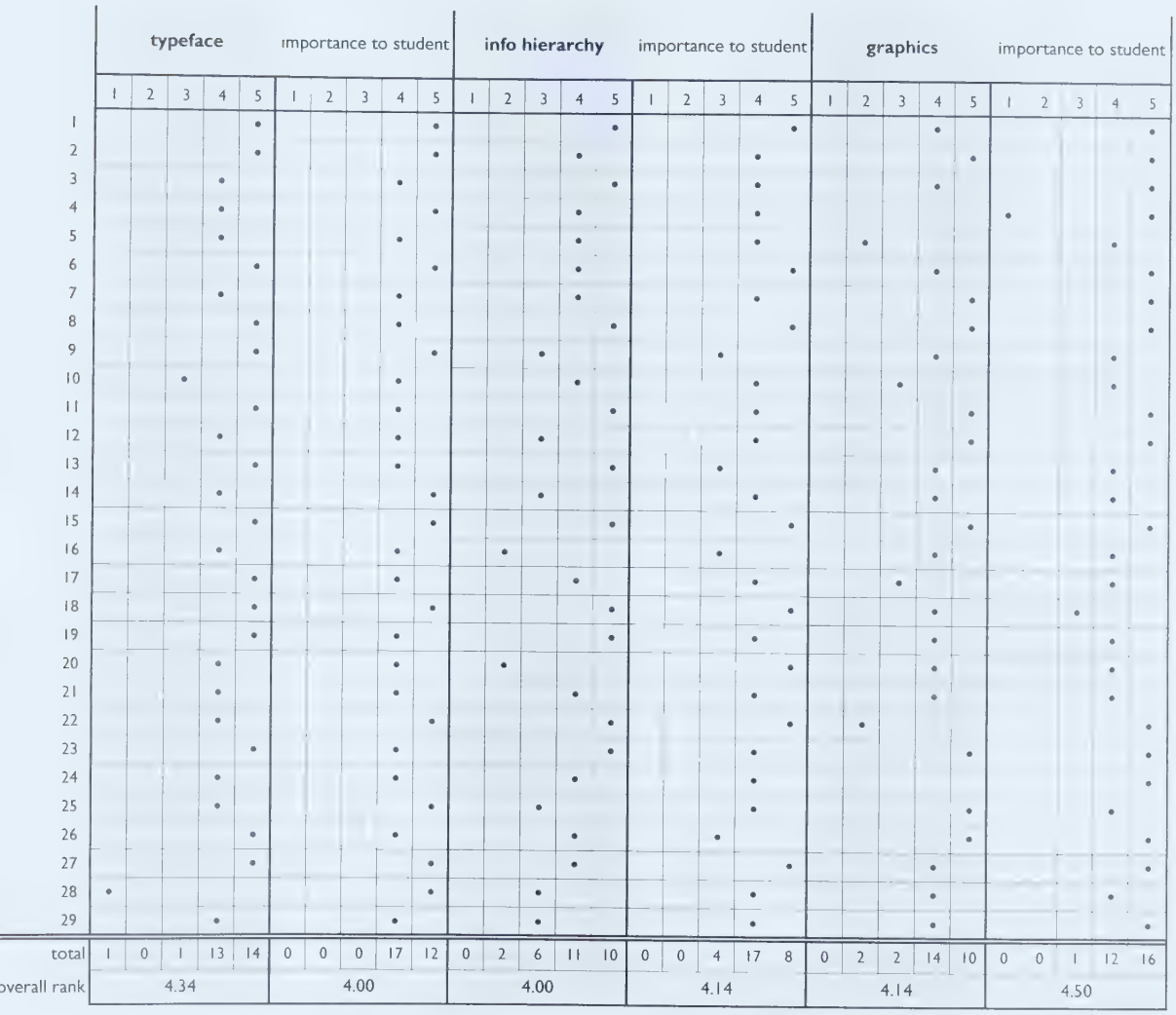
The coil binding is a must because it makes the book very easy to handle when you fold it in half. The size of the book is great! It fits my bag perfect! (The advantage is that the book is thinner and longer, therefore the more stuff you can fit in your bag). The book would work well if it was in a (landscape) format because I like to put my book in front of the computer screen. However the disadvantage would be more turning the pages to follow the steps. It would be nice if the cover and back were made out of thicker paper so it is easier to fold it back up.

The main thing I would change about the workbook is the cover. I find the existing cover too flimsy. A more rigid cover would help the book stay vertical in my bookshelf, as well as, improve the overall durability of the workbook.

The only thing is the cover. I love the design, but mine is already tearing at the coil a bit. Oh. It is nice also that it was only a $25 book —one of the most inexpensive ones yet—and very useful!

I find the workbook a little awkward—it's long and floppy. I find that its cover gets bent.

WORKBOOK CLARITY


typeface
importance to student
info hierarchy
importance to student
graphics
importance to student
1 2 3 4 5
1 2 3 4 5
1 2 3 4 5

WORKBOOK CLARITY
qualitative responses

I find the section on the horizontal line after an instruction has been given on the left, that the font and shading for what the computer comes with "on the command Line" to give you your next prompt—I have difficulty reading that line in the dimmed lighting in the lab.

The command prompt section could stand out a little more. Maybe surround it in a block or highlighted.

I find to work though this book is really easy. With offering how to enter in the command, as well as offering an illustration, as well as what comes up and telling what you should think or notice. Almost like having a tutor right beside me.

Icon graphics need to be bigger font size—or colour change. Perhaps bolding or putting items in boxes would help to clarify problem.

In some cases it is hard to tell which line is selected (dashed) to perform functions.

The dark background in text boxes make words difficult in read. Could it have a slightly higher value?

Some are confusing.

Very easy to follow and bolding the keywords is very effective.

Some of the graphics are small and hard to read. The only difference this makes is that I tend to look at the diagrams—not read the words. When I do read the words and not just look at the diagrams—they are much clearer.

I think it is awesome

Command line graphics are hard to read.

The graphics all look the same at first, and it does make it easier to find them, but I was just getting confused by them, maybe because some of them weren't the right ones.

Personally, I find that typing a one or two letter command on the keyboard is faster and easier to remember than the graphic icons. However, I understand that everybody learns differently—and can see the importance of incorporating different learning styles.

I find the typeface too small to read.

I like the pictures because it helps you know for sure what it is supposed to look like and do.

Black type on toned background, especially the darker background, does not provide enough contrast for my aging eyes.

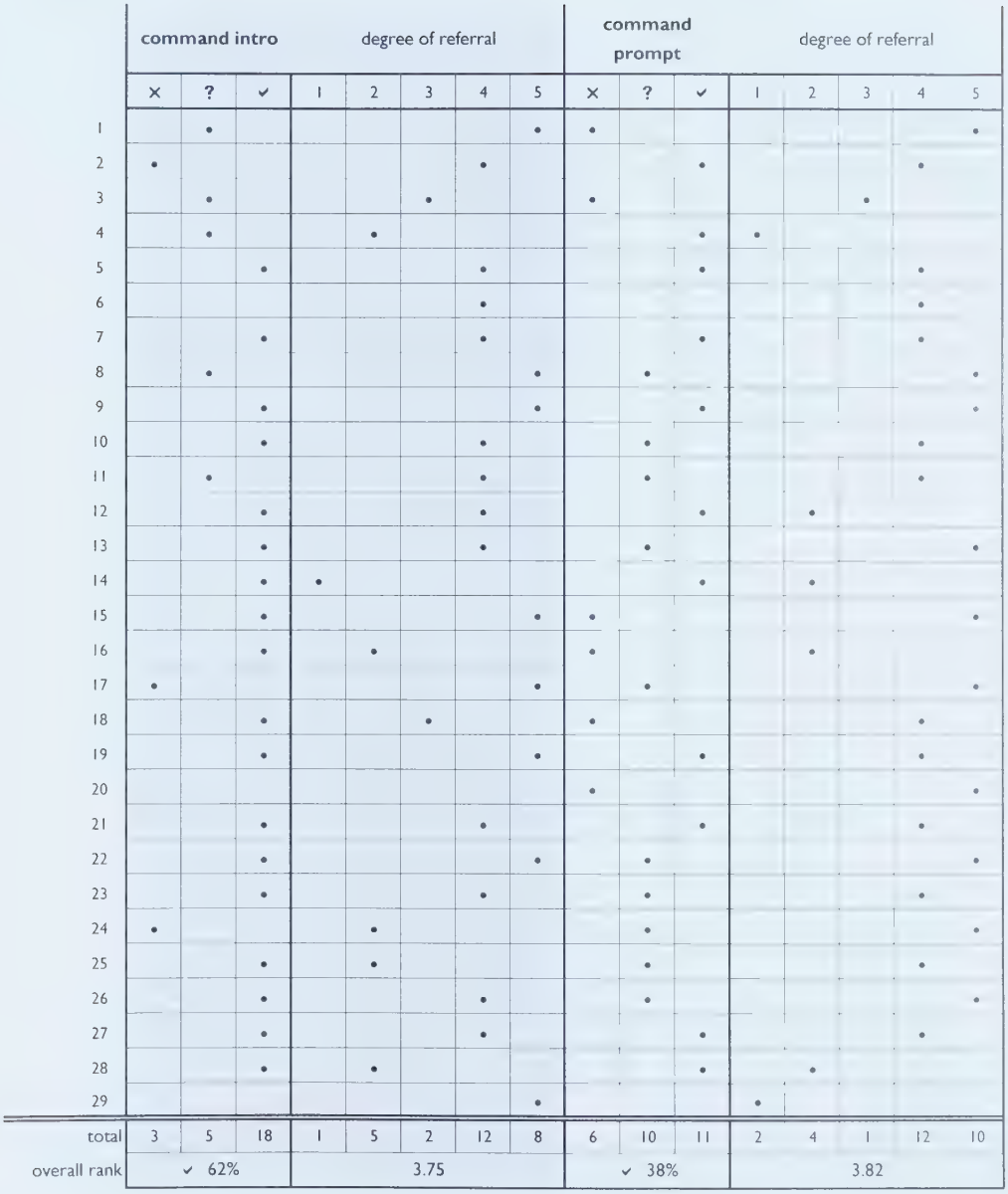
Graphics are great!

I am a visual learner + the workbook graphics have helped me a lot!

Perhaps the graphics could be slightly larger but not a big deal overall.

The ease of reading the different typeface sizes varies depending on location. In some areas it is wonderfully clear, but in the shaded boxes of practice assignments it would be nice if "command": was boldface as well, otherwise I tend to gloss over the written command box.

LAYOUT PREDICTABILITY



	command intro			degree of referral					command prompt			degree of referral				
	×	?	✔	1	2	3	4	5	×	?	✔	1	2	3	4	5
1		•						•	•							•
2	•						•				•				•	
3		•				•			•					•		
4		•			•						•	•				
5			•				•				•				•	
6							•								•	
7			•				•				•				•	
8		•						•		•						•
9			•					•			•					•
10			•				•			•					•	
11		•					•			•					•	
12			•				•				•		•			
13			•				•			•						•
14			•	•							•		•			
15			•					•	•							•
16			•		•				•				•			
17	•							•		•						•
18			•			•			•						•	
19			•					•			•				•	
20									•							•
21			•				•				•				•	
22			•					•		•						•
23			•				•			•					•	
24	•				•					•						•
25			•		•					•					•	
26			•				•			•						•
27			•				•				•				•	
28			•		•						•		•			
29								•				•				
total	3	5	18	1	5	2	12	8	6	10	11	2	4	1	12	10
overall rank	✔ 62%			3.75					✔ 38%			3.82				

× = incorrect response

? = neither correct nor incorrect

✔ = correct response

information referral ranking

1 = never

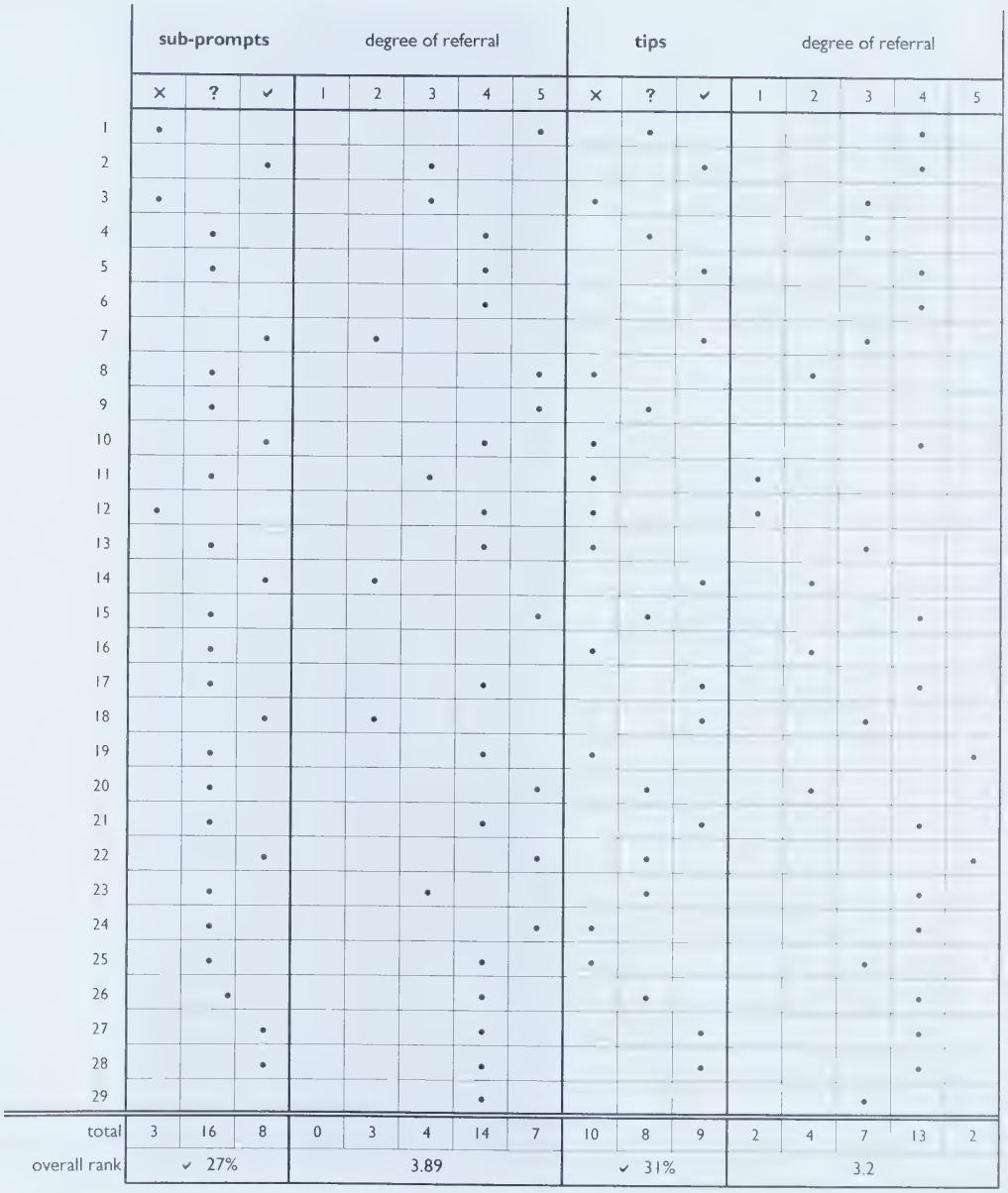
2 = sometimes

3 = neutral

4 = often

5 = always

LAYOUT PREDICTABILITY



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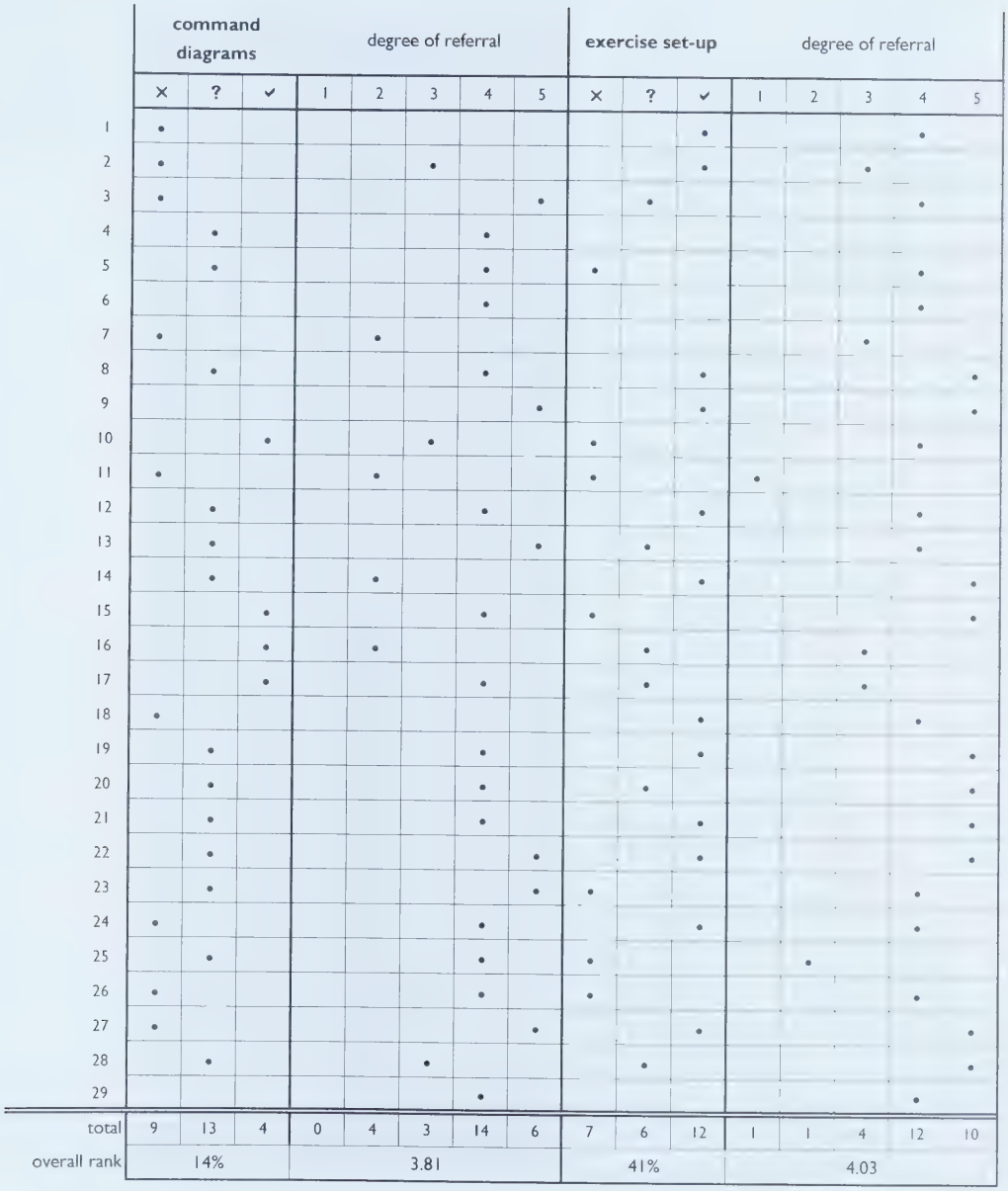
LAYOUT PREDICTABILITY



	command diagrams			degree of referral					exercise set-up			degree of referral				
	×	?	✔	1	2	3	4	5	×	?	✔	1	2	3	4	5
1	•										•				•	
2	•					•					•			•		
3	•							•		•					•	
4		•					•									
5		•					•		•						•	
6							•								•	
7	•				•									•		
8		•					•				•					•
9								•			•					•
10			•			•			•						•	
11	•				•				•			•				
12		•					•				•				•	
13		•						•		•					•	
14		•			•						•					•
15			•				•		•							•
16			•		•					•				•		
17			•				•			•				•		
18	•										•				•	
19		•					•				•					•
20		•					•			•						•
21		•					•				•					•
22		•						•			•					•
23		•						•	•						•	
24	•						•				•				•	
25		•					•		•				•			
26	•						•		•						•	
27	•							•			•					•
28		•				•				•						•
29							•								•	
total	9	13	4	0	4	3	14	6	7	6	12	1	1	4	12	10
overall rank	14%			3.81					41%			4.03				

× = incorrect response

? = neither correct nor incorrect

✔ = correct response

information referral ranking

1 = never

2 = sometimes

3 = neutral

4 = often

5 = always

GUIDED EXERCISES LAYOUT

	interpretation of contents in column A			interpretation of contents in column B			interpretation of contents in column C			interpretation of contents in column D			layout of guided exercises helpful?					importance of layout predictability				
	×	?	✓	×	?	✓	×	?	✓	×	?	✓	1	2	3	4	5	1	2	3	4	5
1			•			•			•			•					•					•
2			•	•			•					•				•					•	
3			•			•			•			•				•						•
4			•			•			•			•					•				•	
5			•			•			•			•					•					•
6																						
7			•	•			•			•						•					•	
8			•			•			•	•							•					•
9			•			•			•			•					•					•
10																						
11			•			•			•			•					•			•		
12			•			•			•			•					•					•
13			•			•			•			•					•		•			
14			•			•			•	•							•					•
15			•			•			•			•					•					•
16			•			•			•			•				•					•	
17			•			•			•			•					•					•
18	•				•				•			•				•						•
19			•			•			•			•					•					•
20		•			•				•			•					•					•
21			•			•			•			•					•				•	
22			•			•			•			•					•					•
23			•			•			•			•				•						•
24			•			•	•					•				•					•	
25		•				•			•			•				•				•		
26		•				•		•				•					•				•	
27			•			•			•			•					•					•
28			•			•			•			•				•					•	
29			•			•			•			•			•							•
total	1	3	23	2	2	23	3	1	23	3	0	24	0	0	1	9	17	0	1	2	9	16
overall rank	✓ 85%			✓ 85%			✓ 85%			✓ 88%			4.59					4.42				

× = incorrect response

? = neither correct nor incorrect

✓ = correct response

helpfulness ranking

1 = not helpful at all

2 = not helpful

3 = neutral

4 = helpful

5 = very helpful

importance ranking

1 = not important at all

2 = not important

3 = neutral

4 = important

5 = very important

GUIDED EXERCISES LAYOUT

qualitative responses

Excellent set up table format allows the user to read/follow the info best suited to their learning type. Set up well for references needed at a later date.

Tabs would really be helpful. Borders on sides to distinguish various sections. Darker typeface. I seem to have a feeling that it is not as dark as it could be, this seems to be a perception in my memory.

I can't remember where info is off hand but I can find it easily in the book.

I find the layout very easy to follow.

It would be great to have a column to write our own hints, reminders. Tabs to find info would be great.

The "4 steps, A,B,C,+D" are great because that way you can always double check to see if you are doing something right. (Explaining steps in different ways is very helpful.)

An introduction at the beginning of the book letting you know what information is in the shaded or plain columns would help me know where to look for information & what to expect.

(Never look in column D because I know I don't refer to that information.)

I think that the set up is great, it gives you every possible way of completing an exercise in an ordered manner.

The layout seems extremely well set up, it is very helpful.

layout predictability is very important for quick + easy reference.

Some of my responses in this section may appear more negative than they really are. Some tools—like the 'tips' box—do not help me because I tend to jump around and plunge right into the exercise without properly reading the instructions, and I sometimes just like to experiment on the computer. The booklet really is quite user-friendly to a complete beginner, and I greatly appreciate it, but being a visual learner, I have a bad habit of looking mostly at the images/icons and doing the practice exercises. The practice exercises are wonderful because I learn by doing.

NAVIGATION

difficulty ranking

1 = very difficult

2 = difficult

3 = neutral

4 = easy

5 = very easy

importance ranking

1 = not important at all

2 = not important

3 = neutral

4 = important

5 = very important

rate of referral ranking

1 = never

2 = sometimes

3 = neutral

4 = often

5 = always

NAVIGATION
qualitative responses

The navigational tool in the upper right hand corner needs to be larger and perhaps index tabs would be helpful in finding sections. I find I have to search the book every time I need to review a section because it's (sections) are not clearly indicated.

I prefer tabs. Assignments are hard to find between chapters.

Perhaps die cutting along the edge of the book (similar to a personal phone directory) with the icon image. FUN!

Excellent set up

I don't really find navigation through the book a problem mostly because it is so small. And working through each page I know approximately where info is.

Need tabs on edges for quick reference.

To navigate from section to section, I would like to have tabs on the side separating them.

Big bold letters + colours for sections.

My suggestion is that when a new command is introduced and then you are to use it in later exercises I think it would be very helpful to reference the page the command is on.

While working through the book I need to constantly refer back to previous commands. I find it hard to relocate the info and the navigational device is not helpful because it is too small & I still need to flip so many pages to find what I need.

I didn't notice (the side index) was there until last class!

I usually go from memory of where things are.

Tabs would work good too!

I find it hard to figure out exactly where something is in the book that I need to review again.

I think the navigational device is a great outline idea. I have only used it once/twice, as I knew the commands previously; However, if I had not known what to look for, I believe I would use it more. Great idea!

It would be much nicer if there were maybe tabs that stuck out with the heading, or the edges of the page were colour coated.

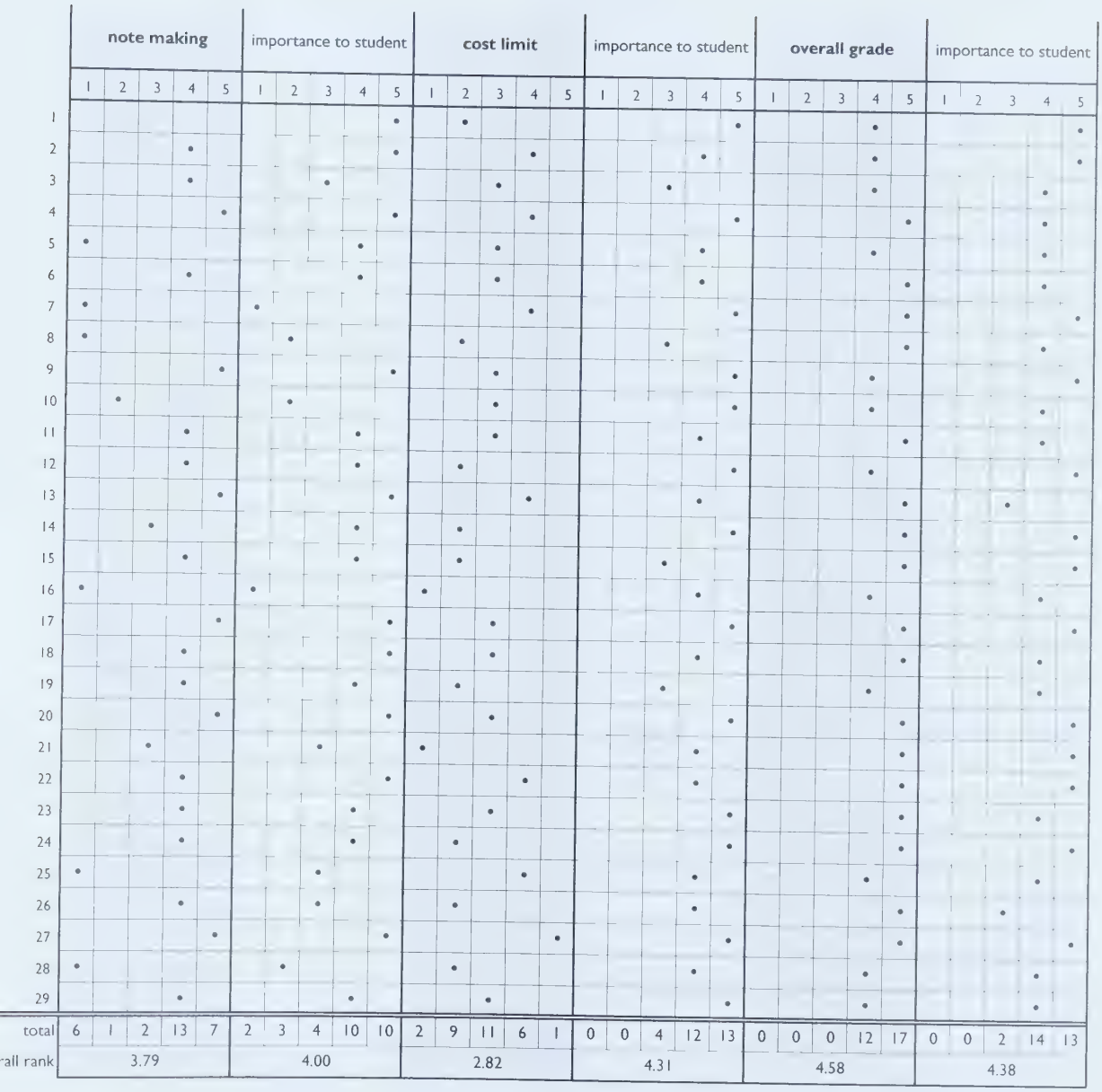
Tabs would be good for flipping back. Especially to pages with assignments on them. Because it is hard to find previous pages of info.

Quick reference is of great importance in a fast-paced learning environment.

The navigation box is so small and pressed in the corner that I don't see it. I would prefer a box with only the one word on it, not several words.

Colour would be great in the book to demarcate sections and important information, but I realize budgetary concerns make it quite unrealistic to actually do this. I would rather have a very durable cover to the book than colour anyways.

MISCELLANEOUS



quality ranking

1 = poor

2 = fair

3 = neutral

4 = good

5 = very good

importance ranking

1 = not important at all

2 = not important

3 = neutral

4 = important

5 = very important

cost ranking

1 = $30

2 = $40

3 = $50

4 = $60

5 = $70

overall grade ranking

1 = F

2 = D

3 = C

4 = B

5 = A

MISCELLANEOUS
qualitative responses

Love the coil, the grid/table format. Pages have no raz-ma-taz colour perhaps, colour coded?

Allow a column for notes. No limit on price depending on how effective. I would not let cost deter me, however need value for my dollar. I think despite some needed improvements this manual is self-explanatory and has aided in my learning. Lessons are easy to follow and can be done on your own.

Easy to follow. Good transitions between topics. Would like to have tabs.

Value changes. Improve please. Very consistent in format which is great. Your eye knows exactly where to look for info. Simplification of command really helps.

An index would be great and a glossary too. A small column for notes would be very helpful and useful. Helpful hints (such as refer back to such and such page for....) just for a quick reminder. Also a shortcuts page at the end of the book would be great. It would be great if there were more practise exercises because I think that is a great way to learn by actually doing it. (Exercises just for fooling around would be ideal and as well a some fun, challenging exercises to do on your own time (just for fun!) So far, so good. I think this manual is great for starting learners! I would definitely recommend it to others.

I find the work book to be very useful. The instructions are specific and helpful. My main concern with the manual is with the difficulty in retrieving specific information. An index would be helpful or a table of contents at the start of each chapter.

All textbooks for school are expensive—I would like to pay less and usually it is waaaa more. I would pay more for this book because I am actually using it!! I think it is great. I still can't believe you are doing this for your thesis!! It is working well for me—things like question 17+18—I didn't notice it was there because I wouldn't use it. THAT'S ME I GUESS. The only thing as it is not really easy to look back on different things we have done. But I can't think of a solution—so it must not be that important.

I like the workbook and use it.

The step by step explanations are great, however, I find it hard to find certain commands when I go back to look for them.

I believe there is a great variation of user-friendly materials to learn from. Overall, I give it an A layout and design.

I think the information and the set up are great. I am mostly concerned with durability, and simplifying the sections.

I love this workbook. It is self-guiding and self-explanatory. Perhaps more page references to previous commands would help.

There are mistakes that need fixing but we have been fortunate for us that most have been found. Overall I think the workbook is a fantastic learning tool. It helps me in my learning because everything is their pretty much that we need.

I like the way it seems like a workbook as opposed to a text. I can write in it and not feel bad. It's also great that its so cheap especially in comparison to the rest of the interior design program.

Good book easy to read, easy to understand. Needs easier access to previous info.

Colour?

I think you have done an awesome job on the manual. Very well thought out! You can learn without being at class.

Visual images work well (a picture is worth a thousand words). I like the fact that images and/or words are not crammed together. Instead they are comfortably surrounded by a visually pleasing amount of negative space (and psychologically less intimidating). The cover needs to be stronger. It's a good manual and I would like it to last.

Sometimes I find that there are minuscule details missing in terms of keying in commands. This sometimes has faultering effects on completing a command. Overall I am grateful for this (bible) manual—as I am not an aural or visual learner.

WORKBOOK EFFICACY

	confidence level with autocad					usefulness of workbook					% workbook contributed to skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1			•						•				•		
2				•						•					•
3				•						•					•
4		•						•					•		
5				•					•					•	
6				•						•					•
7				•					•					•	
8				•					•						•
9															
10			•						•						
11				•						•				•	
12					•					•				•	
13				•						•			•		
14				•						•					•
15				•					•					•	
16			•						•				•		
total value	0	1	3	11	1	0	0	1	7	8	0	0	4	5	6
overall rank	3.75					4.43					4.13				

confidence ranking	*usefulness ranking*	*percentage ranking*
1 = not confident at all	1 = not useful at all	1 = 0%
2 = not confident	2 = not useful	2 = 25%
3 = neutral	3 = neutral	3 = 50%
4 = confident	4 = useful	4 = 75%
5 = very confident	5 = very useful	5 = 100%

WORKBOOK EFFICACY
qualitative responses

How would you rank your confidence level with using AutoCAD?

I really like AutoCAD. I know I will feel quite confident when I spend more time on it from a day to day basis.

Can do almost anything—eventually. Still have questions about some things.

I feel the workbook has helped increase my skills, and I know enough to figure things out on my own.

At first I was intimidated by now I feel very comfortable and confident with it.

I feel I have retained a lot of the information I learned, and concepts that I have forgotten are easily sourced from the textbook.

I missed 3 classes and was able to catch up on 4 hrs. reading through the sections I missed.

Some areas need more practice i.e. view ports.

Because there are a couple of commands (i.e. chamfer) that I'm not in the practice of using very much, I don't know how to use them properly. Overall I like the program and feel I can run it well.

Part of the confidence comes from knowing that the information is in the book and also in knowing how to use 'help'.

The basic tools to create drawings are relatively simple if used frequently.

I really enjoy it and feel comfortable on everything I have learned.

I think that because we only have 1 class a week, the new information we're taught is getting 'lost' between each class. For me anyway, it seemed like too much in a 4 hour class, once a week.

How useful has the workbook been for learning how to use AutoCAD?

I like the layout, had a flow to following it along.

Easy to follow.

Steps are extremely helpful and easy to understand.

Step by step instructions which is very helpful because you can learn by yourself.

Although I prefer learning by example, the textbook is so basic and step-by-step that I find it easy to follow.

The step by step exercises were easy to follow.

I've needed to check back on many things and having a reference is wonderful!! As well, it helps to work through it step-by-step and I need this to learn.

The help tool in autocad does not explain the functions well, nor is it user friendly. The workbook provides simple easy to understand language.

I feel I could have learned this just by the workbook.

Do you think there is anything that should be added or reinforced in the workbook to promote a better understanding of AutoCAD?

Playing around helps a lot. Could use more icon pictorials.

Trouble shooting area, i.e. hatch.

It's easy to see, read and understand, rather than watching someone do it, it is laid out step by step in front of you allowing one to work at their own pace.

I like to figure things out on my own. (It's too easy to just follow the steps without learning anything.

I would say after the workbook it's practice practice practice! (workbook could use quick/easy tips)

It is very hard to follow instructions in the class. I think it is easier to learn while you are doing it instead of being told what to do. There could be more practice exercises so you could play around and learn more by yourself.

Learning by doing is important to me so having a book that took me through the process was very helpful.

Needs references.

I learned lots from the people around me. "one-on-one".

I need also the balance of class instruction, but I rely on being able to go back when I've forgotten something. (You took away the reference tabs on the side. They are very helpful to me and I would prefer to see them there.

The teaching is very important to see first. But the book makes the knowledge sink in.

the teacher is an excellent instructor and together with the workbook has enhanced my learning.

It's excellent—step by step and idiot proof.

Colour!

A list of quick tips we could look up in the back to tell us in brief, a key element or instruction to complete a task, the new or shorter way we're taught as the course moves on.

WORKBOOK CONTENT + ORGANIZATION

	adequate content?					logical and easy to follow?					manageable module size?					challenge well-balanced?				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1				•					•						•					•
2					•					•					•					•
3					•					•					•				•	
4			•					•				•					•			
5					•					•			•					•		
6					•					•				•						•
7					•				•					•						•
8					•				•					•					•	
9					•					•				•					•	
10				•					•					•					•	
11				•						•					•				•	
12					•					•					•					•
13					•					•					•					•
14					•					•					•				•	
15					•				•						•					•
16			•							•				•					•	
total value	0	0	2	3	11	0	0	1	5	10	0	1	1	6	8	0	1	1	7	7
overall rank	4.56					4.56					4.31					4.25				

adequacy ranking

1 = not really

2 = fair

3 = neutral

4 = for the most part

5 = yes

CONTENT + ORGANIZATION
qualitative responses

Do you feel that the amount of material included in the workbook was adequate to learn how to create a set of architectural drawings?

It made things easy to learn, and if you didn't understand a specified aspect you could always go back to the book for ref. and work through it again.

Can easily create a document however a little more is needed to create an excellent, unique set of drawings.

Except I believe we could have worked more on the layouts, so we could become very fast at that.

Enough of a basic knowledge of AutoCAD was established that any unknown info could be learned through AutoCAD's 'help' menu.

A few things needed clarification because it was new material.

I think there are probably short cuts and tricks we'll learn later, but we know enough now to do a set of drawings.

Used workbook for playhouse construction drawings.

I did a set of working drawings for my construction course using just the workbook and class info.

I feel I know the very basics, but I do not feel we've had enough class time with these workbooks to feel very confident.

Was the curriculum organized in a fashion that was logical and easy to follow?

Available tabs would be good to tab our own very important parts.

I think it would be better if we had the class for shorter amounts of time because that way the info would stay in your head better if you had the class twice a week instead of one. With only one class you always had to refresh your mind.

Tabs would be nice.

Progressed nicely.

It was gentle in its guidance.

Nicely spaced out.

More tabs / divisions of sections.

Very easy to follow (icon pictures helpful!) Sometimes an explanation /instruction took 8 pages to get through...any way to simplify this in connection to/with verbal instruction?

Was the curriculum presented in manageable amounts?

The lessons were quick and simple yet I learned what I needed to know.

Easy to follow.

I usually had to go back and refresh on lessons.

Sometimes too much was learned in one day resulting in my forgetting some information.

In the book yes, in class, no.

The beginning was overwhelming, I really felt like it was sink or swim.

I found that I got through everything, however, there was not enough time to work on/practice during the class (It seemed to take up ¾ of our time)...and I wouldn't have a chance to touch it until the following week, which didn't really help me retain everything very well.

Was the curriculum presented in such a way that kept you challenged but not overwhelmed?

Can be worked through alone if need be.

The book was so easy to follow there was no room to be confused or overwhelmed.

Not really challenging.

The pace was sometimes too fast.

Too much was given on some days and not enough on others.

At certain times it seemed there was a huge amount of information-too much at one time. But it was easily adaptable to be managed.

I was always learning something new, which I liked.

After the first couple of classes.

I felt it could have been a bit more condensed and I don't have much previous computer experience.

I guess, just because of the workload in all my other 5 classes, autocad didn't really get worked on until the night before. I think really, this is a class that should be taught twice a week—just to give us more practice hours to become really familiar with it.

EXERCISES + ASSIGNMENTS

	exercises useful?					rate of completion					assignments useful?				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1					•				•					•	
2					•					•					•
3				•						•				•	
4			•						•				•		
5			•							•				•	
6					•					•					•
7					•					•				•	
8				•						•				•	
9					•				•						•
10					•			•							•
11					•					•				•	
12					•					•					•
13					•					•				•	
14					•					•					
15					•					•				•	
16				•					•				•		
total value	0	0	2	3	11	0	0	1	4	11	0	0	2	8	5
overall rank	4.56					4.62					4.20				

usefulness ranking

1 = not useful at all

2 = not useful

3 = neutral

4 = useful

5 = very useful

rate of completion ranking

1 = never

2 = 25% of the time

3 = 50% of the time

4 = 75% of the time

5 = always

EXERCISES + ASSIGNMENTS

	feature of curriculum that best contributed to learning				error recovery: **exercises**				error recovery: **assignments**				updated *Learning Style Inventory* for learning AutoCAD				original LSI
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	stage
1	●	▪		○	○		●	▪	●	○		▪	●	▪		○	3
2		▪	○	●	●	○		▪	●	○		▪		●	○	▪	1
3		○	▪	●	●	○		▪		●	○	▪	▪		○	●	4
4		▪	●	○	○		●	▪	○	▪		●	○	▪	●		2
5	●	▪		○	▪	●	○		●	○		▪	●	▪	○		1
6	●		○	▪	●	○		▪		○	●	▪	●	○	▪		4
7		▪	○	●		●	○	▪		●	○	▪	●	▪	○		4
8	▪	○	●			○	●	▪	○	▪	●		▪	○	●		2
9	●		▪	○	●	▪	○			●	○	▪	●	▪	○		2
10		▪	●	○	○	●		▪	○	●		▪	○	▪	●		2
11	▪	○	●		●	○	▪		●	○	▪		▪	○	●		1
12	▪		○	●		○	●	▪		○	●	▪	▪	○	●		2
13	●	○		▪		○	●	▪		○	●	▪	●	○		▪	2
14		▪	○	●	○	●		▪	●	○		▪	●	○		▪	3
15	●		○	▪	●	○		▪	●	○		▪	○		●	▪	4
16	▪	○	●		●	○		▪	▪	○	●		▪	●	○		_
total value	0	5	6	5	4	9	3	0	3	10	3	0	3	6	6	1	● = first choice
total value	6	0	5	5	7	4	5	0	6	4	5	1	7	2	6	1	○ = 2nd choice
total value	6	4	3	3	4	2	7	3	6	0	7	3	1	2	3	10	▪ = 3rd choice
total value	4	7	2	3	1	1	1	13	1	2	1	12	5	6	1	4	= 4th choice
overall rank	2.12	2.18	2.93	2.75	2.87	3.31	2.62	1.18	2.68	3.37	2.62	1.31	2.44	2.5	3.06	1.94	

learning feature

1 = working with classmates

2 = instructor input

3 = guided exercises

4 = solo assignments

error recovery

1 = consulting an instructor or classmate

2 = re-reading and working back through the exercise

3 = experimenting until I got things right

4 = moving on to something else

learning profile

1 = divergent

2 = assimilating

3 = convergent

4 = accommodating

EXERCISES + ASSIGNMENTS
qualitative responses

How useful were the step-by-step practice exercises for helping you understand how AutoCAD commands work?

I think they are good, depending sometimes it's nice to work all the way through things.

Do the steps while the instructor does them.

The typeface could be larger or darker.

Give more time in class to work through them.

Sometimes there would be the tiniest detail missing which would throw you off.

I think they're excellent the way they are.

Shortened? A lot of verbal visuals, which sometimes was a bit distracting. Even arranging things horizontally, instead of vertically. I know personally, photographic memory works best this way for me, to read from left to right.

How would you modify the assignments?

They were great in helping me to develop the skills I had acquired from the text.

Utilized skills learned.

Practice makes perfect.

By doing the assignments, even several times it made you analyze the different ways you can come about building a drawing. (Smaller assignments in the beginning of the term so that there is more constant use of the basic commands).

Yes, much more than the exercises.

They pertained to everything we were doing.

I like the way they are.

Colour diagrams.

It's hard to comment on sort of…I was there, I did them all, and yet it still feels kind of unfamiliar still. Maybe its just me though? (Learning annotating, keying dimensioning in the middle would have given us more time to get used to this. Viewports! I'm still a little confused about setting up…we didn't spend enough time on these. Maybe could have been introduced earlier.

INDEPENDENT LEARNING

	workbook used to catchup/work ahead?					% workbook used to learn					would you purchase autocad software?	
	1	2	3	4	5	1	2	3	4	5	yes	no
1			•					•				•
2				•					•			•
3	•								•		•	
4		•							•		•	
5		•								•		•
6					•				•		•	
7		•							•		•	
8				•				•				•
9				•				•			•	
10				•					•			•
11			•				•				•	
12	•								•		•	
13					•			•			•	
14			•						•		•	
15				•				•				•
16				•				•				•
total value	2	3	3	6	2	0	1	6	8	1	10	6
overall rank	3.18					3.62					62.5%	37.5%

rate of use ranking

1 = never

2 = not often

3 = neutral

4 = often

5 = always

percentage ranking

1 = 100% instruction

2 = 30% workbook / 70% instruction

2 = 50% workbook / 50% instruction

2 = 70% workbook / 30% instruction

2 = 100% workbook

INDEPENDENT LEARNING
qualitative responses

Did you ever use the workbook to either catch up or work ahead?

Good for a class missed.

If I had the program at home I probably would. Since we only have autocad once a week it never was a priority to try to work ahead.

Sometimes class pace was too slow so I'd go on to the next practice exercise.

Went away and had to catch up on 3 lectures.

I did a little bit.

I just followed along as we went. I never had to catch up. I didn't want to get ahead in case I missed part of the instruction.

Catch up!

I stayed with the pace.

To work ahead.

Catch up! (other workloads!)

How did you best learn to use the AutoCAD software?

Instruction was helpful, but I learned the most from working through the book on my own.

Instruction followed workbook.

And by myself.

Instruction in class is hard to follow because you are not physically practising it.

I learn best by seeing someone demonstrate how something works, then doing it myself by going through the workbook lessons.

I learned mostly from my classmates and also from the workbook.

I learn best under the instruction and example that I can follow. Repetition is also where I learned and here the book helped me a lot as a reference.

I found the workbook most helpful.

Lots of in-class help from other instructors, aside from books.

What would be needed in the AutoCAD curriculum in order to run a successful independent learning option?

Further detail in reading on or a place to go for help.

Opportunities for assistance, if needed.

The workbook is fairly independently set up now.

More practice exercises.

Perhaps a slower pace since no one would be around to help when needed.

Smaller exercises/binder for a book to print out certain command functions from the help menu, notes, etc.

Perhaps a one-one-one help staff and not someone instructing.

I don't know. I know I would prefer to be in a class situation to learn this. Some of the things I didn't understand in the book initially because it's all new material.

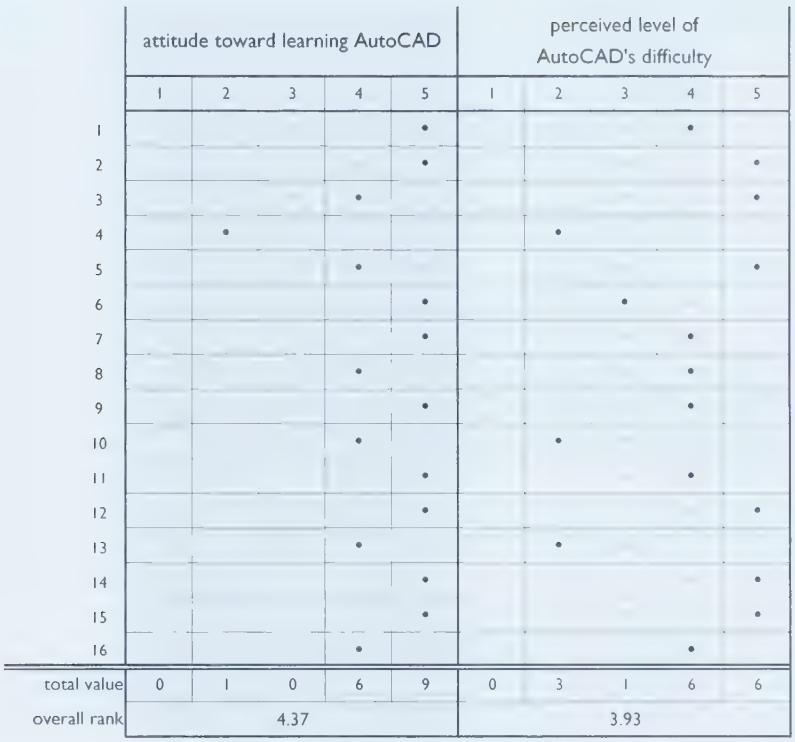
If possible, a visual CD-ROM to go with it would be nice, that would go through examples and teach exercises.

Graphic examples on a computer program showing the diff. commands in action.

Instruction from internet.

More class time I think, so that we can become comfortable with the software, and confident enough to go it alone at home without assistance.

FINAL LEARNER ATTITUDE



	attitude toward learning AutoCAD					perceived level of AutoCAD's difficulty				
	1	2	3	4	5	1	2	3	4	5
1					•				•	
2					•					•
3				•						•
4		•					•			
5				•						•
6					•			•		
7					•				•	
8				•					•	
9					•				•	
10				•			•			
11					•				•	
12					•					•
13				•			•			
14					•					•
15					•					•
16				•					•	
total value	0	1	0	6	9	0	3	1	6	6
overall rank	4.37					3.93				

attitude ranking

1 = very negative

2 = negative

3 = neutral

4 = postive

5 = very positive

difficulty ranking

1 = very difficult

2 = difficult

3 = neutral

4 = easy

5 = very easy

○ = perception after 1st class

● = perception after last class

FINAL LEARNER ATTITUDE
qualitative responses

Now that you have experienced 12 weeks of AutoCAD instruction, what is your attitude toward learning AutoCAD?

By people's talk I figured it would be a lot more difficult.

It's worth learning, easy to learn and efficient.

User-friendly.

At first it is intimidating but before you know it, it becomes second nature.

I came to like autocad until I spent too much time in front of a computer screen. It can be a great tool but tedious at times.

It takes the frustration of erasing and doing details is so much easier.

Practice makes perfect. Watching someone demonstrate on a screen doesn't really help unless you can follow step-by-step along with the screen doing it!

It's not as difficult as everyone makes it sound. Once you get the basics down, you perfect your technique in drafting (line weight, etc.).

I love it!

I really enjoy it, I prefer it far beyond hand drafting. I am looking forward to doing CAD in my work term.

I think I've learned some great basics, but I just feel like there's a lot I 'went through in class', but have forgotten over the 12 weeks.

What has it been like for you to learn the AutoCAD software?

I think you did really well putting the workbook together.

I find computers come naturally to me so the workbook was easy to understand and within CAD itself I felt capable of figuring things out myself.

I think the workbook is a great tool. I wish you luck with its success!

Tabs to find sections easier.

I have had mostly technical difficulties. (such as completely freezing, etc.) That has only really been the tough part.

Although not a learning comment, I really feel both the front and back of the workbook should be made out of a durable material. I dislike trashed and mangled books and stop using them when they get overly damaged. Other than this, the workbook is pretty darn good. I wish there was a detailed index at the back, though. The table of contents tends to be too general.

Positive/fun. Improve: Have an appendix for ideas/steps that are frequently used. Polar coordinate charts. Foot and inches charts. Layers charts.

Somewhat difficult, I don't know any other related programs.

The software isn't challenging if you're computer literate. It's just understanding the program and how to use it. I found the workbook an exceptional reference and learning tool!

It was easy to follow. I think it was very successful. It worked very well for myself and the way I learn. Thanks! I love the book!

I do not have a great deal of computer experience.

I thought it would be a lot more difficult.

Hard cover, tabs/dividers, colour diagrams.

I think it was a really good first run. Just a few simple adjustments and MORE class time, I think, would really add to our accessibility and confidence levels. Thanks!

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